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HOUSE OF LORDS

SESSION 1990–91
1st REPORT

SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY

INNOVATION IN MANUFACTURING INDUSTRY

VOLUME I—REPORT

Ordered to be printed 29th January 1991

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(Q) refers to a question in oral evidence in volume II;
(P) refers to a page in volume II;
(p) refers to a page in volume III.

CHAPTER 1 INTRODUCTION

1.1 Manufacturing industry is vital to the prosperity of the United Kingdom. Manufactured goods are tradeable around the world, they have high added value, and their production provides an economic base on which the services sector is largely dependent. The increasing penetration of the home market by imports (Figure 1), the resulting deficit in the balance of trade in manufactured goods (Figure 2) and our poor performance compared to our competitors (Figure 3) are therefore cause for serious concern.[1] Our manufacturing base is dangerously small; to achieve adequate growth from such a small base will be difficult. A vicious circle has been formed. The balance of trade deficit puts pressure on exchange rates thus contributing to high interest rates. High interest rates discourage investment and further weaken our manufacturing base. The vicious circle will only be broken if industry in the United Kingdom becomes more competitive.

1.2 Innovation is crucial to the competitiveness of manufacturing industry. Without it, United Kingdom companies cannot increase their share of world markets. The introduction of new or improved products, which meet the needs of the customer quickly, reliably and at a competitive price, gives a company an edge over its competitors. As Lord Weinstock, Managing Director of the General Electric Company Ltd, said, "Innovation is indispensable in maintaining a successful business . . . If you do not change as the times, the markets and products require, you are dead" (Q 1623).

1.3 The Committee has therefore conducted an enquiry into "the pursuit of innovation in manufacturing industry in the United Kingdom". We have looked at the conditions which stimulate innovation and the obstacles which hinder it. Failure to innovate has been a significant factor in the decline in manufacturing in the past[2] and best use of technology will increasingly be a factor in success in the future. A climate in which innovation can more readily flourish is urgently needed.

1.4 Recently a number of bodies have considered the subject of innovation from a variety of angles. The Innovation Advisory Board of the Department of Trade and Industry (DTI) has looked at financing and the question of "short-termism"; the National Economic Development Office (NEDO) has reviewed the attitudes and methods of companies with a successful innovative record; and the Confederation of British Industry (CBI) has launched an annual Innovation Trends Survey.[3] We hope in this report to draw these threads together, and to consider the subject as a whole.

WHAT IS INNOVATION?

1.5 Innovation in manufacturing industry is the commercial application of knowledge or techniques in new ways or for new ends. It is a process which encompasses many disciplines and types of activity, including research, design, development, manufacture and marketing of a new or improved product and new or improved methods of production. It may involve radical innovation (such as the introduction of satellite communications) or incremental innovation (such as reducing the number of components in an electrical appliance). In each case the innovator achieves a competitive advantage, at least until another company catches up or goes one better.

1.6 The "Frascati manual" of the Organisation for Economic Co-operation and Development (OECD) gives a widely accepted definition of scientific and technological innovation. "Scientific and technological innovation may be considered as the transformation of an idea into a new or improved saleable product or operational process in industry and commerce or into a new approach to a social service. It thus consists of all those scientific, technological, commercial and financial steps necessary for the successful development and marketing of new or improved manufactured products, the commercial use of new or improved processes and equipment or the introduction of a new approach to a social service."

1.7 Innovation then is more than just research and development (R&D). Indeed, one witness observed that "companies may not need huge investment in R&D to innovate well" (P. 242).

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[1] We recognise that some of the economic problems which we discuss in our report are the consequence of our current position in the business cycle. But they are also indicative of a long-term, deep-rooted problem.

[2] The role of technical change in international competitiveness has been well documented. See, for example: K Pavitt (Ed) (1980), *Technical Innovation and British Economic Performance*, MacMillan; E Arnold (1985), *Competition and Technological Change in the Television Industry*, MacMillan; L G Franko (1989), "Global Competition: Who's Winning, Who's Losing, and the R&D Factor as One Reason Why", *Strategic Management Journal*, Vol. 10, pp. 449-474; L Soete (1987), "The Impact of Technological Innovation on International Trade Patterns: The Evidence Reconsidered", *Research Policy*, Vol. 16, Nos. 2-4.

[3] We also draw attention to our earlier report, *Engineering R&D*, 2nd Report 1982-83 (HL Paper 89-I) which dealt with some of the factors relevant to innovation specifically in connection with the engineering industries.

NEDO's Innovation Working Party described innovation as covering "major advances in the performance of a product, process or service, the cumulative combination of incremental improvements and the creative combination of existing techniques, methods and ideas which lead to a major advance".[1] Other witnesses gave similar definitions (PP. 84, 93). One witness emphasised the importance of ongoing change: "manufacturing innovation is mostly made up of incremental developments and investments rather than glamorous high-technology leaps" (P. 33). The CBI Survey showed that some two-thirds of expenditure on innovation was "aimed at improving existing products or creating additional variants".[2]

1.8 Sir Geoffrey Allen, a former Chairman of the Science and Engineering Research Council, and former Head of Research of Unilever plc, described innovation as having three parts. "The first one was not R&D; it was identifying market opportunity or market need. The second part probably did involve R&D, certainly if a technical solution was needed to meet that opportunity. The third part—which many people forget about—is the question of having a business plan" (Q 1711).

1.9 Innovation is not, of course, confined to high-technology industry, nor indeed to manufacturing. It is equally important in areas such as marketing, packaging, and customer services. Indeed, change in those parts of a business are often necessary for the successful exploitation of a new product or process. We, however, have concentrated primarily on technological change, whether in a leading-edge area such as biotechnology or in a more traditional sector such as machine tools.

INNOVATION—A RISKY BUSINESS

1.10 Innovation is far from being an activity in which success is assured. Evidence from 3i plc suggested that "those managements that encourage innovation should be prepared to accept a certain number of failures en route to developing a successful product or process" (p. 102). Sir Robin Nicholson, director of Pilkington plc, said "you do not have R&D programmes without having failures. If you do . . . it means that you are not being sufficiently vigorous and ambitious"(Q 1247).[3] A survey of new product failure in the USA indicated average failure rates of about 30 per cent for industrial products and 40 per cent for consumer products.[4]

1.11 It is important therefore to use the inevitable failure constructively. Sir Geoffrey Allen said that "if you are to be innovative you have to be resilient about failure . . . the main job of senior management is to get people on their feet again and to have a go somewhere else" (QQ 1750, 1751). A company must not be disillusioned by failure but must regard it as an integral part of the learning process rather than an opportunity to apportion blame.[5] Indeed the knowledge gained from failure can be instrumental in achieving subsequent successes.[6]

HOW IMPORTANT IS INNOVATION?

1.12 The importance of innovation was clearly explained in evidence from Peat Marwick McLintock. "If a company does not keep up with the rate of technological innovation then it is very difficult to recover lost ground at any future stage. A company that can gain even a small innovative advantage over its competitors . . . has the opportunity to build upon its early lead at every stage" (P. 174). In a climate of increasingly sophisticated and individual consumer demands, the successful company is the one with the innovative lead.[7] This is clearly recognised by our competitors. Mr Koichi Danno, Vice-President of Mitsubishi Heavy Industries Ltd, told the 1990 Aviemore Forum "top-quality products and leading-edge technology will be indispensable to any manufacturer seeking to establish itself in international markets".

1.13 The central position of innovation to a company's success was widely acknowledged. One witness described it as "a prerequisite for survival" (P. 17) while another said that "a company's ability . . . to innovate . . . constitutes perhaps its most important, but intangible asset" (P. 83). Mr A P Balding, Managing Director of the Beaver Engineering Group, said that while a reduction in company spending on product innovation would improve the annual profit statement it would "result in collapse in 4-5 years" (p. 222). He explained vividly how his company had survived by meeting new markets with new products, while many other United Kingdom machine tool companies had gone under (Q 1375). No wonder then that Professor Michael Porter of the Harvard Business School described innovation as "the central issue in economic prosperity" (Q 1184).

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[1] NEDO memorandum, unpublished.

[2] CBI Innovation Trends Survey, Issue 1, p. 8.

[3] See also Q 1061; P. 250.

[4] C M Crawford (1987), "New Product Failure Rates: A Reprise", *Research Management*, Vol. XXX, No. 4, July-August, pp. 20-24.

[5] See PP. 41, 45, 226; see also *Attitudes to the Exploitation of Science and Technology*, CEST, January 1990.

[6] See for example M A Maidique and B J Zirger (1985), "The New Product Learning Cycle", *Research Policy*, Vol. 14, No. 6, pp. 299-313.

[7] A recent DTI publication gave some prominent examples of companies whose success depended on specific innovations. See *Innovation and Growth*, Innovation Advisory Board, June 1990. See also *Design and the Economy*, Design Council, 1990.

1.14 Inevitably, however, the level of innovation necessary for competitiveness varies widely from one industrial sector to another, and indeed within one sector from company to company and from time to time. Factors affecting it include the breadth of opportunities afforded by scientific and technological advances, the intensity of competition between companies, the length of a product life-cycle and the size and sophistication of the market. The same factors will also have a bearing on whether radical or incremental innovation is required. Incremental as well as radical innovation needs to be strategically managed and even in low technology industries a continuous commitment to innovation is necessary.[1]

1.15 Innovation is not only necessary in existing businesses. The role of new enterprises in contributing to the country's innovative performance is significant. New companies have been particularly important in the growth of emerging or rapidly-changing technologies such as biotechnology, electronics, scientific instruments and computer hardware and software.[2]

THE INNOVATIVE RECORD IN THE UNITED KINGDOM

1.16 It is not easy to measure innovation for, as we explained in paragraphs 1.5 to 1.9, many activities contribute to it and most of them cannot be quantified. Nor can its output be readily assessed. But patents are at least a partial measure of innovative performance.[3] Figure 4 shows that the United Kingdom's share of all OECD national patent applications fell during the 1980s, though with a slight up-turn in 1987. The performance of France, Germany and the USA was similar. Japan, on the other hand, has made a substantial increase in its already disproportionately large share of patent applications.

1.17 Although their relation to innovation is not straightforward, R&D and capital investment are two inputs which can be measured.[4] The United Kingdom was the only country in which Gross Domestic Expenditure on R&D (GERD)[5] declined as a percentage of Gross Domestic Product (GDP) over the period 1981 to 1988 (Figure 5). The proportions of GERD financed by government and industry, respectively,[6] reveal that this decline was largely the result of the reduction in Government support for R&D (Figure 6). Furthermore although the proportion of GERD financed by industry increased over the period 1981-1988, it did so at a rate below that of our competitors (Figure 7). Gross Fixed Capital Formation (GFCF), as a percentage of UK GDP, was below that of most of our major competitors (Figure 8). However the United Kingdom and Japan were the only two countries in which GFCF increased as a percentage of GDP, over this period. It is significant that the Japanese had a higher level of investment in GFCF than any other industrial country—indeed the OECD consider that it was the interaction of this investment with the high level of investment in GERD that enabled the Japanese economy to absorb technical innovation (i.e., exploit R&D) more quickly than the other large OECD countries.[7] Gross Fixed Investment in UK manufacturing industry as a percentage of GDP has continued to decline since the early 1960s (Figure 9).

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[1] See for example R Rothwell and P Gardiner (1989), "The Strategic Management of Re-Innovation", *R&D Management*, Vol. 10, No. 2, pp. 147-160.

[2] See R Rothwell (1989), "Small Firms, Innovation and Industrial Change", *Small Business Economics*, Vol. 1, No. 1.

[3] The OECD uses patents as an indicator of invention. The main drawbacks to this are that not all inventions are patented, and that the technical and economic value of an invention varies markedly from one patent to another.

[4] The OECD use Gross Domestic Expenditure on R&D (GERD) as a measure of "non-physical investment" in scientific and technological knowledge (i.e. R&D which is capable of generating innovations) and Gross Fixed Capital Formation (GFCF) as a measure of "physical investment" in fixed assets, such as plant and equipment and construction (i.e. that investment necessary to exploit R&D).

[5] GERD is a measure of total civil plus defence R&D. In comparing GERD as a percentage of GDP it is important to take account of the distorting influence that major defence programmes in some OECD countries have on the total figure. Roughly half of UK GERD is defence related. Furthermore much of that defence expenditure is not R&D at all in the sense of the Frascati definitions. See Science and Technology Committee, 3rd Report (1989-90): *Definitions of R&D* (HL Paper 44).

[6] UK GERD in 1987 was financed by Government (38.7 per cent), industry (49.7 per cent), other national sources (2.5 per cent) and abroad (9.2 per cent).

[7] *OECD Science and Technology Indicators*, Report No. 2, 1986, p. 19.

1.18 Capital Investment by manufacturing industry in the United Kingdom fell substantially in the early 1980s (Figure 10).[1] Although gross investment has risen steadily since then it has only recently achieved the levels of investment of the 1970s. Furthermore Figure 11 shows that there was virtually no net investment[2] in UK manufacturing industry during the 1980s. Marked improvements in productivity and profitability have been achieved during the 1980s (Figures 12 and 13). However these have not been reflected in as large a growth in profitability or output as that achieved by some competitors (Figures 14 and 15). Current levels of output of manufacturing industry in the United Kingdom are falling (Figure 16). Furthermore the more rapid growth in imports (Figure 1) and the consequent deterioration in the balance of trade in manufactured goods (Figure 2) show that our competitors are more successful in producing goods the customer wants to buy.

1.19 Witnesses' views of United Kingdom industry's record in innovation were mixed. Lord Weinstock said "I think we are very innovative" (Q 1628). Another witness considered that there is a "low awareness in many sectors of industry" of the need to innovate (P. 99). Mr Ivan Yates, Deputy Chief Executive (Engineering) for British Aerospace, said that in the United Kingdom since 1945 there had been "a lower level of investment in research and development . . . a lower level of investment in capital for manufacturing equipment . . . and a lower level of investment in raising the skills level of the workforce and in training than in nearly any other competitor country" (Q 706).[3] Kleinwort Benson Investment Management Ltd suggested that "UK companies have expended great efforts, and capital, in the application of technology to their manufacturing processes" with a "significant rise in capital investment expenditure during the last three years" (p. 167) though as we have shown this rise was from the low level to which investment had dropped in the early 1980s (Figure 10) and net investment has only now returned to the level reached in the late 1970s (Figure 11).

1.20 Sir Martin Wood, of Oxford Instruments, said that "one of the most surprising things in this country is that we have some of the best examples of industry and some of the worst almost side by side" (Q 1034). Only when many more companies can match the standard of the very best will the United Kingdom have an industrial record to be proud of. According to Sir Robin Nicholson there is not yet, in industry as a whole, sufficient "understanding of the absolute imperative of innovation" (Q 1234). We hope in this report to contribute to such an understanding.

THE INDUSTRIAL CLIMATE OF THE 1990s

1.21 The climate of the 1990s is already very different from that of earlier years. A report commissioned by the DTI[4] shows clearly the opportunities as well as the difficulties which industry faces. They include intense competition through increased liberalisation of markets; globalisation of markets and suppliers; increasingly sophisticated technologies; demand for choice and customisation; greater environmental concern and awareness; recruitment difficulties; and accelerated rates of technological change leading to shorter product life cycles. In such a competitive climate, advantage through innovation will be more important than ever.

1.22 Many witnesses were less than optimistic about the prospects for industry meeting these challenges. Sir John Harvey-Jones, former Chairman of ICI plc, said that while he was optimistic about the future of Europe he was "less sanguine about the prospects for this country playing the part . . . it could and should play in Europe" (Q 2227). Mr Yates said "I have the feeling even some of the world-class companies would not do any better than our best companies, given the environment in which we operate" (Q 709). The Association of the British Pharmaceutical Industry (ABPI) suggested that "the climate for investment in the UK, and therefore innovation in the UK, is not as promising as it was" and drew attention to investment overseas by United Kingdom companies (P. 7). Others also foresaw problems ahead (QQ 184, 433, 507, 2126). In the pages which follow we try to identify the reasons behind this gloomy scenario, and make recommendations for the future.

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[1] In 1989 fixed investment was divided between plant and machinery (83 per cent), new buildings (11 per cent) and vehicles (6 per cent).

[2] Net Investment is defined as gross fixed investment (i.e. total expenditure on new fixed assets) less depreciation of existing fixed assets, where depreciation is measured at replacement cost.

[3] See also P. 143.

[4] *Manufacturing into the late 1990s*, PA Consulting Group, 1989, HMSO.

CHAPTER 2 CULTURAL AND HISTORICAL INFLUENCES

2.1 Attitudes to innovation are coloured by the past and by general social and cultural influences. Conservatism of the home market, access to undeveloped markets in the Empire and then the Commonwealth with little or no competition, adversarial industrial relations and strict demarcation within the workforce, are among the factors which arguably have engendered a less-than-wholehearted commitment to innovation on the part of industry. Witnesses discussed the role of markets, labour force, public attitudes and cultural conditioning.

2.2 Some witnesses spoke of the general manufacturing environment. Professor Porter listed some of "the critical attitudes and beliefs in Britain that get in the way" of innovation. He cited disinclination to compete, reluctance to complain, poor attitude to work and the low value attached to the creation of wealth as factors inhibiting industry in the United Kingdom. "Each of those things . . . affects demands, it affects rivalry, it affects motivation" (Q 1191). The Electronics and Business Equipment Association (EEA) noted that "the United Kingdom manufacturing environment is amongst the most mature in the world. It has patterns set in the past which may militate against innovation" and it "has not been subject to fundamental reconstruction" (P. 112). The Fellowship of Engineering said "the restricted size of the UK home market requires a typical UK company to seek perhaps 80 per cent of its sales in less friendly overseas environments" and that this was a disadvantage compared with the USA or Japan (p. 64).[1] GKN plc commented on the "more restrictive functional specialisation amongst employees than elsewhere in the European Community" and on the "hierarchical form of career development which is not necessarily conducive to the commercial exploitation of significant new knowledge and techniques" (P. 132).

2.3 Others spoke of the status of manufacturing in society as a whole. Lord Weinstock observed that to explain industry's record "you have to go back through history to find out why we are as we are and why we think as we do. You have the education system; the cultural background; the social hierarchy" (Q 1628). The common perception of manufacturing as dirty, dull and unrewarding has been an obstacle to innovation, as the most able in society often do not even contemplate a career in industry.[2] The relatively low remuneration and poor recognition of those involved in wealth creation is a deeply-rooted phenomenon which was strengthened in the 1980s with concentration on financial markets and other services. Sir John Harvey-Jones noted that lack of interest in industry was reinforced by the lack of "industrial heroes" and the fact that "many of our great leaders of industry deliberately seek to avoid publicity and the high ground" (QQ 2195, 2201). The Fellowship of Engineering said that we must do something on a national scale to make people realise that manufacturing is important, interesting and creative (Q 445).

2.4 Others again spoke of lack of interest in innovation itself. The Electronic Components Industry Federation (ECIF) suggested that "much of the public associates innovation with the world of fashion and 'gimmickry'" and does not appreciate its fundamentally important role in industry (P. 109). The Engineering Council commented on the "inherent lack of regard, in UK society, for those involved in technical and innovative work" (P. 119). Other witnesses strongly echoed these ideas.[3] Figure 17 demonstrates the gravity of the situation in terms of career choices by students in the United Kingdom. Figure 18 shows the situation in some other European countries. **It is clear that the importance and value of industry must be more widely recognised if the United Kingdom's innovative record is to improve.**

CHAPTER 3 COMPANIES

3.1 It quickly became clear to the Committee that, while unsuccessful companies have a wide variety of problems, companies which innovate successfully, and flourish, have much in common. Lucas Industries plc, a company which has improved its performance substantially in recent years (see for example pp. 282, 283), showed how learning from other companies' best practice can help in achieving positive results (Q 1658).

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[1] On the other hand a small home market has not in the past been a handicap to industry in other countries with small home markets, such as Sweden, Italy and Switzerland.

[2] This has been widely commented on in the past, notably in *Engineering our Future*, Report of the Committee of Inquiry into the Engineering Profession, Cmnd 7794. For an account of the cultural and social influences in the United Kingdom which have been inimical to industrial and economic progress, see *English Culture and the Decline of the Industrial Spirit 1850-1980*, Martin J Wiener, Cambridge University Press, 1981. For a historical account of the long-standing neglect in the United Kingdom of training and vocational education, and even of basic scientific literacy, see *The Audit of War*, Correlli Barnett, MacMillan 1986.

[3] PP. 84, 93, 109, 130, 266, 286; p. 230; QQ 1025, 1196, 1654.

3.2 Good general management, open and flexible organisation and effective communication between all parts of the company are all structural features which permit a positive attitude towards change. Performance features, such as willingness to adopt external technologies and the fostering of close relationships with customers and suppliers, are equally important. We consider first the structural features, then the performance features, displayed by innovative enterprises.[1]

STRUCTURAL FEATURES OF INNOVATIVE FIRMS

3.3 The organisation and structure of a company inevitably affects its ability to innovate, as it affects the contribution of each individual in the business. The Institution of Production Engineers said that "company structures are the prime limiting factor to innovation" (P. 153).[2] Dr John Parnaby, Group Director for Technology of Lucas Industries plc, said "The key is organisational change. Many of the new techniques and technologies are useless in a relative sense until you have that" (Q 1657).

3.4 Witnesses suggested that organic, cellular structures enable a company to respond to opportunities in a more flexible way, pursuing promising avenues rapidly and enthusiastically and, just as important, abandoning unsuccessful projects in a timely fashion.[3] Mr Gerard Fairtlough, then Chief Executive of Celltech, described the cellular structure in some detail, citing intensive internal communication, constant communication with other cells in a network, and continual evolution to meet changing circumstances, as among the features desirable in company organisation (p. 132). The Fellowship of Engineering talked about a "general flattening of company structures" with "fewer reporting levels and therefore direct communication" (Q 352). Delegation of authority to an appropriate level was also thought to be important in prompting innovative thinking (P. 137; p. 284).

3.5 The NEDO Innovation Working Party observed that "successful innovation management is not found in isolation but it is always associated with excellent general management".[4] This point was confirmed by other witnesses.[5]

3.6 It is all the more disturbing then that some witnesses had such a low opinion of the quality of management generally in United Kingdom industry. Mr J S Kerridge, Chairman and Chief Executive of Fisons plc, suggested that "probably the biggest single deterrent to success in this country is the poor calibre of top management . . . this is far more important than any other single malaise that is normally associated with British industry" (p. 230). He went on to acknowledge that functional management is generally competent but stressed the lack of good strategic management (p. 231; Q 1429). His views were echoed by others.[6] More optimistically, witnesses from 3i and Prudential Portfolio Managers Ltd. suggested that there had been a significant improvement in management quality in the 1980s, though there was still scope for progress (QQ 662, 923). The Secretary of State for Trade and Industry, the Rt. Hon. Peter Lilley MP, also perceived a recent improvement in management quality (Q 2299).

3.7 A point on which there was a striking degree of agreement among witnesses was that it is absolutely essential for the top management of a company to demonstrate commitment to and enthusiasm for innovation and technical change. The Fellowship of Engineering said "it has to start right at the top . . . Senior management have to believe that the combination of technology, finance and market are all important" (Q 351).[7] GKN said "unless a positive commitment is made by management, innovation is unlikely to happen" (P. 131).[8] Only one witness suggested that "the board room is perhaps not the best place to foster innovative thought" (P. 15).

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[1] The characteristics of innovative firms have been the subject of much academic research and other study. For further material see for example *The Successfully Innovative Firm: Some Research Results*, Professor Roy Rothwell, prepared for European Conference on Regional Development, Innovation and Technology, October 1988, Bilbao (mimeo, Science Policy Research Unit, University of Sussex); *The Innovation Management Tool Kit*, published for NEDO by HMSO in association with Barclays Bank plc; *The Competitive Advantage of Nations*, Michael Porter, MacMillan 1990.

[2] See also P. 20.

[3] See Q 1657; PP. 13, 41.

[4] NEDO memorandum, unpublished.

[5] See for example Q 1244; PP. 85, 261.

[6] See for example PP. 33, 226.

[7] See also QQ 93, 253, 1677; PP. 153, 261.

[8] See also P. 75.

3.8 However, witnesses did comment on the lack of technical qualifications among top management, particularly compared to other European countries and Japan.[1] In view of the role which it is widely accepted management has to play in support of innovation, this must continue to be a serious cause for concern.

3.9 The collective quality and enthusiasm of the people at all levels of a company are inevitably important to the process of innovation. BP said "People are the key to innovation" (P. 41),[2] and GKN said that availability of the right people would be "a key consideration" in deciding on the location of investment in innovation (P. 135). Glaxo said "No matter how good a company's organisation, its successful operation depends on people" (P. 137). Other witnesses emphasised the role of the initiative and drive of the individual who could act as a "product champion".[3] Celltech described how, especially in the early stages, much depended on "individuals with a sometimes fanatical dedication to a potential innovation" (p. 131). Sir Geoffrey Allen said "there must always be one man who is determined to see it [an innovation] through, whatever else happens. I have never seen one succeed without that element" (Q 1715).

3.10 **To sum up then, the available evidence shows that some of the structural features which characterise an innovative company are:**

(a) An informed, committed leadership of innovation by board and management.

(b) Direct and frequent communication between all levels and sectors of the business.

(c) Delegation of responsibility to smaller, self-contained units, while maintaining clear strategic direction from the top.

(d) Flatter, less hierarchical structures.

(e) Company culture favouring the involvement of committed product champions.

Performance features of innovative firms

3.11 Given the contribution made by individuals it is not surprising that it is also important for a company to show commitment to its employees and to provide strong motivation and perhaps incentives for good performance. BP suggested that "the personal risk to staff who are adventurous and prepared to try something new must be minimised. A reward system which motivates innovative behaviour must take account of the higher risk, greater difficulty and longer time frame of product/process developments compared with normal operations" (P. 41). The Engineering Council wrote of the need for "personnel policies which encourage professional growth, and reward performance and technical achievement" (P. 119). Other witnesses urged similar points.[4]

3.12 Glaxo described two procedures which they operate to promote staff involvement in innovation (P. 136). Quality circles and staff suggestion schemes have become more widespread in recent years and encourage innovative thinking among employees.[5]

3.13 The proper management of career development was widely recognised as a major tool for involving staff wholeheartedly in the company and getting the best from them. It also diminished turn-over of valued skills.[6]

3.14 The case for breaking down the barriers between disciplines and functions within a company was strongly argued. Mr Patrick McHugh of Coopers & Lybrand Deloitte, drawing on his experience of visiting Japan and looking at certain aspects of Japanese industry, noted that "you do not find in a Japanese company the rigid function boundaries that we have round us all the time in British industry"; instead "they tend to organise themselves into cross-functional teams . . . I suspect that this is the real cause that underlies their success and ability to reduce so dramatically their lead times" (Q 476).[7]

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[1] See for example QQ 85, 1028; P. 132.
[2] See also for example QQ 621, 1015; p. 62.
[3] See PP. 244, 262.
[4] See for example PP. 81, 249; p. 62.
[5] See for example Q 1670; see also QQ 88, 91.
[6] See QQ 1705, 1876.
[7] See also Q 353; PP. 114, 125, 252; p. 103.

3.15 This type of project approach has the advantage of enabling different aspects of an innovation to be worked on simultaneously rather than sequentially. According to Sir William Mitchell, former Chairman of the Science and Engineering Research Council (SERC), "the traditional British approach of separating product design development from production engineering has been one of the contributing factors in lengthening the time for new technological innovation to reach the marketplace" (P. 266). A number of witnesses described the advantages of simultaneous engineering.[1] Mr McHugh gave a vivid example of a situation in which the sequential approach to design and development had disadvantaged a British company (QQ 476-480).

3.16 Another feature of a successfully innovative firm is a close interest in and awareness of the activities of competitors. Mr James Pilditch, author of *Winning Ways*,[2] explained why. "To innovate successfully companies have to satisfy customers better than their competitors do. Without knowing what customers look for, and without knowing how competitors respond to those wishes, that is hard to do" (P. 243). Other witnesses made the same point.[3] On our visits to Germany and Italy, and in formal evidence too, we found that lively, successful companies had a clear picture of their competitors and their comparative strengths and weaknesses.[4]

3.17 Professor Porter made a different point about competition. He suggested that simply the existence of domestic (rather than international) competition acts as a spur to innovation, promoting rapid transfer of information, a diversified approach to similar problems and local rivalry (QQ 1184-5). We certainly found this to be the case in Italy, where regional concentrations of industry (such as textiles in the districts of Biella and Prato) prompt rapid innovation.

3.18 The role of the customer was emphasised by a variety of witnesses. Mr Pilditch described successful innovators as being "obsessive about customers". They have a "thirst for knowledge of customer behaviour and wishes [which is not] confined to the defined marketing or market research people. Everyone is involved. R&D people make service calls, engineers talk to shoppers loading their cars, chairmen talk to customers" (P. 243). ICI said that "without customers, no innovation . . . can succeed" and that "it is the customer, or the market, which largely determines what development ICI should be doing, and where the company's innovative effort should be directed" (P. 147).[5]

3.19 Yet 3i was not optimistic that a proper commitment to the customer is prevalent in industry. They said that "lack of understanding of markets is a major weakness of many businesses" and saw it as a matter of concern that 40 per cent of companies which they surveyed regarded lack of market information as unimportant to the introduction of innovation (p. 103).[6]

3.20 Quantel proved to be unusual in their view of the market, because of the nature of their business. They regarded themselves as a technology-led, rather than a market-led, company making products at the leading-edge of technology for which no demand is yet apparent (Q 1090). All the same, they still put "intense effort . . . into getting under the skin of the person who we expect to use the equipment. The key person in all our developments is the person who is going to use it" (Q 1154).

3.21 Professor Porter spoke of a demanding home market as "a great advantage in keeping up with the innovation race" (Q 1184). The Committee found on its visit to Italy that the sophistication of the Italian consumer was widely regarded as a prime factor in keeping the standards of Italian industry high. The importance of the home market applies as much to capital goods manufacturers whose customers are other companies as it does to manufacturers of consumer goods (for example washing machines or food products) whose customers are individual consumers.

3.22 Many witnesses perceived an improved relationship between companies and their suppliers, with less emphasis on low price and more on quality and long-term contacts. The Fellowship of Engineering welcomed the "trend towards long-term collaborative relationships between companies and suppliers, particularly where these include some degree of risk-sharing.

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[1] See for example p. 118; PP. 13, 193.

[2] Mercury Business Books, 1989.

[3] See for example Q 380; PP. 153, 261.

[4] QQ 567, 844-5.

[5] See also PP. 42, 156; QQ 1843, 1845, 1868.

[6] See also P. 243; Q 1733.

Such relationships are perceived to result in benefits for both parties . . . Traditional adversarial relationships are undoubtedly to the detriment of both innovation and quality. The former arms-length relationship of purchasing only from the lowest price supplier is outmoded" (p. 66). The EEA agreed that "many companies . . . are tending to reduce the number of competitive suppliers, to fewer preferred suppliers with long-term and sometimes risk-sharing contracts" and noted that this benefitted technology transfer in both directions (P. 117). The advantages of such collaborative relationships, in promoting loyalty and trust, and an ability for companies to work together in the search for quality, were widely recognised and it is apparent that the technique is slowly becoming more widespread.[1]

3.23 Some witnesses, however, warned of potential difficulties arising from this development. While recognising the likely benefits, the Trades Union Congress (TUC) feared that closer customer/supplier involvement could lead to a dependent relationship which could be harmful particularly for small suppliers, and urged that new relationships should be "based on partnership rather than the dominance of one company by another" (P. 271). 3i feared that, as more large companies move to single source supply, "there will be less opportunities in the future to break into the supply chain, especially for the smaller supplier" (p. 105). British Steel suggested that distrust could arise as "the technology input of the different parties is rarely equal" (P. 80). These potential problems are all very real, but the advantages appear to outweigh the disadvantages and, in the words of GKN, the trend has already "created an environment which is particularly conducive to innovation" (P. 134).

3.24 **To sum up then, the available evidence shows that some of the performance features which characterise an innovative company are:**

(a) Close attention to customer needs.

(b) Awareness of competitors' activities and strengths.

(c) Trusting, collaborative relations with supplier companies including shared risk-taking.

(d) Breaking down discipline barriers and using multi-disciplinary project teams.

(e) Involvement and motivation of the workforce and commitment to training and staff development.

CHAPTER 4 TECHNOLOGY

4.1 Technological innovation centres on the application of knowledge, whether it be new knowledge or existing knowledge applied in new ways. The acquisition of knowledge is therefore crucial to the innovation process. Knowledge may be acquired by a variety of routes. A business may generate it in its own R&D department, or acquire it from another business, from a privately-funded R&D organisation or from the science base (for example from a university department or a Research Council institute). Different sources have different advantages and disadvantages, and in this section we look at them. It is important to keep in mind, however, that the application of technology in an economically significant way is what really matters—"it is the effective application of new technology which is the crucial factor, rather than its source" (P. 109).

TECHNOLOGY FROM EXTERNAL SOURCES

4.2 Until very recently the United Kingdom was a net exporter of technological knowledge (Figure 19). This demonstrates two points. First, industry in the United Kingdom has perhaps been less open than it should have been to purchasing and exploiting technology from abroad. The technological balance of payments[2] of competitors such as Japan, Germany and Italy (Figure 20) shows that being a net importer of technology is by no means a handicap to economic prosperity.[3] Secondly, Figure 19 suggests that until recently the United Kingdom has been good at invention but perhaps less good at the exploitation of knowledge generated here. This is regrettable for, as

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[1] See QQ 793, 1907, 1908; PP. 14, 44, 98, 111, 121, 134, 155, 254, 262, 267, 270.

[2] The technological balance of payments registers the flow of proprietary knowledge and know-how into and out of a country. It consists of money paid or received for the use of patents, licences, trademarks, designs, inventions, know-how and closely related technical services.

[3] The Committee has noted in an earlier report, "A negative technological balance of payments reflects not some national inadequacy but a willingness to exploit R&D of foreign origin" (*Definitions of R&D*, 3rd Report 1989-90, HL Paper 44, para 1.76).

Sir John Harvey-Jones said, in selling knowledge you do not even recover the cost of developing that knowledge. The main way to make a profit is to exploit knowledge yourself and sell it indirectly through new or improved products (Q 2188).

4.3 A variety of witnesses urged the importance of companies being outward-looking and responsive to new technology wherever it might arise. BP said "no company has a monopoly on new ideas" (P. 42) and suggested that a strong in-house technology resource base "should also provide a window on external technology".[1] Sir Geoffrey Allen suggested that a strength of Japanese companies lay in their commitment to gathering technological information from around the world (Q 1739).

4.4 It is important however that reliance on bought-in technology should not be allowed to undermine in-house ability. The BICC Group said technology transfer is "no substitute for an adequate level of R&D in manufacturing industry" (P. 40). The TUC said "excessive reliance on overseas technology can be harmful in the long-run if it is allowed to suppress creativity in the UK . . . once the country has "opted out" of a particular area, it will be very difficult for it to opt back in" (P. 272). The same is true for an individual company or business. Reliance only on technology generated elsewhere can leave a company, or a country, without the skills and experience needed to identify, adapt or apply technology satisfactorily.[2]

4.5 While the picture is bound to vary from one industrial sector to another, and indeed from one company to another, the general view which emerged from witnesses was that manufacturing industry in the United Kingdom is often reluctant to adopt external technology.[3] A recent survey[4] suggests that most innovation is generated internally: on average 63 per cent of ideas for innovation come from within the company, 28 per cent come from related companies (that is customers, suppliers and competitors), while only 9 per cent of ideas come from completely unrelated sources. Sir Robin Nicholson said that the "Not Invented Here" syndrome "is one of the principal inhibitors of innovation" (Q 1254). Other witnesses shared this view.[5] The finding of the CBI, that "many companies . . . plan to devote greater resources to exploiting external sources of innovation",[6] is more optimistic and long overdue.

4.6 The apparent difference between large and small companies in their willingness to look outside for technology was commented on. The Fellowship of Engineering said "Broadly the larger UK companies are as active as any of their counterparts overseas in keeping abreast of developments at home and abroad . . . the smaller UK companies are not active to the same extent" (p. 62).[7] British Aerospace suggested however that small high technology companies are active in this way (p. 118). But although costs of accessing external technology can be an obstacle for small enterprises, those which are committed to innovation do manage to maintain a dense network of technological collaborators.[8] In Germany we found that a patents data base established by a research institute was frequently used by small local firms to keep up to date with the activities of their competitors.

Relations between industry, HEIs[9] and Research Councils

4.7 Some witnesses from the science base regretted that companies rarely initiate contact with them, and this suggests that companies may be reluctant to look for know-how outside their own R&D departments. The Vice-Chancellor of the Queen's University of Belfast said that "direct approaches from companies [seeking technology] are rare" and that in every technology transfer agreement with industry the University had made the first move (P. 260). This lack of initiative was repeatedly compared with the actions of companies in the USA and Japan. Dr C E Webb, in the Physics Department at Oxford University, told a sorry tale. "My research group is frequently visited (typically twice per year) by trade delegations of up to 20 Japanese industrial scientists. The number of similar visits I get from research scientists in British industry is negligible" (P. 282).[1]

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[1] See also Q 314; PP. 84, 96, 244, 245.

[2] See PP. 13, 119; p. 149; Q 1416.

[3] A sector in which this does not appear to be the case is chemicals and pharmaceuticals: see Q 109; P. 263.

[4] *Innovation in Britain Today*, Bain and Company, 1990, p. 12.

[5] See for example pp. 40, 118; PP. 100, 103, 125, 132, 260, 262.

[6] CBI Innovation Trends Survey, Issue 1, p. 7.

[7] See also P. 128; p. 231.

[8] See for example: C Stockman and J Docter (1987), "Innovation in Manufacturing Medium-Size and Small Enterprises: Knowledge Breeds Prospects", in R Rothwell and J Bessant (Eds), *Innovation, Adaptation and Growth*, Amsterdam, Elsevier; R Rothwell (1989), "SMFs, Inter-Firm Relationships and Technological Change", *Entrepreneurship and Regional Development*, Vol. 1, No. 3, pp. 275-291.

[9] Higher education institutions.

4.8 HEIs have made great efforts in recent years to improve their links with industry.[2] The various mechanisms used by universities to transfer technology to industry include science and technology parks, innovation centres, provision of specialist courses, the Teaching Company Scheme and industrial R&D clubs (P. 94, P. 260). The Fellowship of Engineering welcomed the widespread appointment by universities of Industrial Liaison Officers (p. 65). Imperial College, University of London, has set up a joint venture company with 3i (Q 644). Professor S K Bhattacharyya, of the Department of Engineering at the University of Warwick, has established technology centres in collaboration with particular industrial companies (Q 1504). The CBI said that the prospects for technology transfer between HEIs and industry were improving (p. 14). The NEDC report[3] concluded that such transfer "is increasing in intensity and in scope".

4.9 In their various ways the Research Councils have undertaken similar initiatives. SERC for example has established its Directorate for the Application of Computers in Manufacturing Engineering (ACME) which has resulted in "industrial companies taking up the ideas to produce products and processes that will improve their competitiveness", and the Teaching Company Scheme is also assisting technology transfer (PP. 266-267). Both these schemes are run and funded jointly by SERC and DTI. The Agricultural and Food Research Council (AFRC) "adopts a flexible, case by case approach to exploitation" by means of "industrial contracts and by direct contact with the commercial world" (P. 4). Marketing managers are now being appointed by individual AFRC institutes to co-ordinate these contacts. The Medical Research Council (MRC) has had an Industrial Liaison Group since 1982 and a Collaborative Centre since 1986, and its policy is "to ensure that its intellectual property, inventions and know-how are exploited in the national interest" (P. 224). The Fellowship of Engineering said that "the establishment of AIRTO (Association of Independent Technical and Research Organisations) has been a useful additional step in strengthening the links between Research Councils and Industry" (p. 65).

4.10 Some witnesses however were not content with the present mechanisms for transfer of technology from the science base to industry. Defence Technology Enterprises Limited said that, while the situation is improving, it still suffers from "lack of commercial and legal expertise" on the part of the constituents of the science base and a "lack of overall co-ordination" (P. 101). The Society of British Aerospace Companies (SBAC) saw the cultural differences between HEIs and industry as a problem (P. 268). The urgency of commercial deadlines, for example, is not always clearly understood by academics.

4.11 Small and Medium-sized Enterprises (SMEs) can have particular difficulty in making use of the science base. "SMEs in general have very little appreciation of the nature of the work and the goals of HEIs, and similarly, university staff have little rapport with the methods employed by SMEs" (P. 14). The difficulty for SMEs in finding out what is available and who to turn to for advice was also remarked on (PP. 101, 120). Mr I K Showan, of the Britax Automotive Components Division of BSG International plc, clearly described the difficulties experienced by a medium-sized company in its dealings with HEIs (P. 57).

4.12 It might be feared that the new concentration on technology transfer will undermine the more traditional role of HEIs and Research Councils. ICI plc expressed this concern most clearly: "the present priority given to this activity [interaction with industry] stems more from a desperate need to raise funds than from any natural extension of academic interest . . . the primary job of academy is education and . . . earning money should be a secondary and minor activity. The present emphasis is wrong and if continued will diminish the capacity for education, scholarship and research which are for us the universities' main contribution to the overall process of innovation" (P. 147). Glaxo also suggested that direct technology transfer was not their main expectation of their collaborations with HEIs and Research Councils, but that they valued more highly the exchange of ideas and the two-way transfer of information (P. 141).

4.13 It is clear from the evidence that the most effective means of transferring knowledge from one sector to another is by personal contacts, including the transfer of people whether permanently or on secondment. GKN observed that "technology transfer is essentially a person centred activity" (P. 134) and the Committe of Vice-Chancellors and Principals (CVCP) urged the importance of "personal contact between the staffs of universities and companies, often developed over a period" (P. 93). The Institution of Production Engineers favoured a "flexible arrangement between HEIs and industry, with more people with a foot in both camps" (P. 155). The Engineering Council (P. 120) and others argued for more systematic secondments of people between research centres and industry.[1] Sir John Harvey-Jones welcomed recent improvements in the interface between industry and HEIs, but regretted that movement from one world to the other was still very limited (Q 2185).

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[1] See also Q 385; PP. 39, 99, 225.

[2] For a survey of the mechanisms for technology transfer between HEIs and industry, see *Technology Transfer Mechanisms*, NEDC, February 1989, p. 88 ff.

[3] *Op cit*, p. 4.

GOVERNMENT RESEARCH LABORATORIES

4.14 The specific role of Government research laboratories (as opposed to Research Council institutes and HEIs) was only rarely mentioned but such comment as there was was less than complimentary. Dr C E Webb suggested that the increasingly commercial remit of such laboratories was damaging, leading to a breakdown of co-operation and a stifling of information flows: "it seems to me that the old regime, under which one could talk to Government scientists without being charged by the minute, was rather more productive for both sides" (P. 284). The TUC also felt that the laboratories were in danger of becoming overly subject to short-term pressures (P. 274). 3i said that in a survey of companies, only 2.7 per cent of innovations introduced in the last five years had arisen in Government research laboratories (p. 104). The CBI observed that decreasing use of Government research laboratories by industry was a cause neither for surprise nor concern. Since some establishments had entered the private sector, those which remained in the public sector were "less relevant to the needs of industry and are essentially serving the needs of Government" (QQ 160, 161).

4.15 **To sum up then, the following main points emerged from the evidence:**

(a) Internally and externally generated know-how should be complementary; both are important.

(b) Too many United Kingdom companies have in the past been reluctant to look outside for technology and have made little effort to acquaint themselves with the work of HEIs and Research Councils, but this is improving.

(c) HEIs and Research Councils have made progress in meeting the needs of industry, but it is feared that this activity might undermine their traditional role.

(d) Technology transfer is most effectively achieved through personal contact.

(e) Technology transfer will only succeed if it is part of a well thought-out overall business plan.

(f) Government research laboratories play only a limited role in industrial innovation.

CHAPTER 5 FINANCE

5.1 The ability to finance investment and manage risk naturally influences a company's decisions about innovation. Although a decision to reduce investment—whether in equipment, development or training—will almost certainly in the long run harm rather than help a company's prospects, coats must be cut according to the cloth available. The availability and cost of money are therefore central to attitudes to innovation.

5.2 Financial institutions rightly claim that there is no shortage of money available to fund "good" investments, that is investments with the potential to earn a satisfactory level of profit taking account of the risk involved. But what constitutes a good investment inevitably depends on the attractiveness of alternative opportunities and is strongly influenced by the cost of capital. The scale of investment is also limited by the size of a company's capital base and to exceed this can cause serious damage.

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[1] See PP. 43, 130, 269; p. 62.

"SHORT-TERMISM"

5.3 In recent months there has been widespread discussion of "short-termism", the concentration on enhancing immediate profits, sometimes (for example by neglecting or cutting expenditure on R&D or training) at the expense of future benefits. Much of the argument has focussed on the role of "the City"—insurance and pension fund managers, banks, financial analysts—and its emphasis on share price and quarterly performance. But short-termism is more widely rooted than that. Company managers, for example, all too often receive incentives based on short-term performance. Some serve as trustees of their company pension fund and in that role make the same demands for high short-term performance which they so deplore in "the City". The problem of short-termism is an attitude or perception which is widely held, and will not be solved by one section of the financial or industrial community blaming another.

5.4 The DTI's Innovation Advisory Board has identified "short-termism" as a real problem.[1] It suggested that the dominance of institutional shareholders, the expectation of higher than average returns over a short period, and an inclination to view shares as trading counters, have all led to "a clear preference for dividend payments over R&D".

5.5 Certainly some witnesses from industry were strong in their complaints about the financial community. Oxford Instruments, a successful high-technology company for which research and development are the life-blood, said that two years earlier they had announced an exciting technological venture, but their share price had dropped substantially. The venture was not likely to contribute to earnings until 1992 and stock analysts saw no reason to back the company during the period of investment but could come back into the stock nearer the time of fruition (QQ 1036, 1043). Such reactions could make it difficult for a company to raise capital, could render it vulnerable to takeover or, in the worst case, could discourage management from making long-term investment decisions. Sir Martin Wood said "I think the effect of the City on us at the moment is actually impeding our progress" (Q 1044).

5.6 The Engineering Council clearly explained how short-termism is thought to operate. "The City seems to positively discourage investment in innovation. While it likes to see adequate research and development, it does not like it to be at the expense of current profit growth . . . The City thus acts as "the master" instead of "the servant" of industry, with the emphasis firmly on short-term return" (P. 120). Coopers and Lybrand Deloitte explained that "a focus on growth of earnings per share as a key measure of corporate performance . . . leads to an understatement of corporate value as only short-term earnings are taken into account" (p. 81). Mr Pilditch suggested that the effect of this pressure was damaging to company attitudes. "It commits boards to spend their time on financial matters to the near exclusion of all else" (P. 253). A variety of witnesses had similar criticisms of the City.[2] Some made comparisons with Germany and Japan, where shareholders take a much longer-term view of their investments.[3] Certainly this was shown to be the case on our visit to Germany, where the banks have a close and supportive relationship with industry. On one occasion it was suggested to us that it would be quite acceptable for a German company to refrain from paying out dividend in one year to invest more in R&D, a course which would in the United Kingdom be calamitous.

5.7 Mr Lilley suggested that "short-termism" is a "self-fulfilling phenomenon, because companies have tended to be reluctant to cut dividends except when things are really awful . . . and there is accumulated bad news within the company of which investors and shareholders were previously unaware; consequently . . . everybody has then got the impression that a dividend cut causes the consequent drop in the share price. In fact, a dividend cut made by a company which is fundamentally healthy, but is cutting its dividend because it wishes to maintain its research and development and investment programme, may well be a prudent measure which should not be accompanied by a fall in the share price" (Q 2278).

5.8 Some industrial witnesses did not regard short-termism as a problem. Among them was Sir Geoffrey Allen, who said: "Good analysts give well organised efforts at innovation a good press. The attitude of the City usually is to judge in retrospect. Thus the effect during the emergence of an innovation is not great" (p. 284). He also said that his former company, Unilever,

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[1] *Innovation: City Attitudes and Practices*, Innovation Advisory Board, June 1990.

[2] See for example PP. 10, 13, 101, 131, 154, 268, 273.

[3] See PP. 71, 126.

"expect to get good marks for being good at research . . . We are picking up very good comments from the City because of our R&D" (Q 1792). GKN and others denied that City attitudes had a negative influence (P. 133).[1]

5.9 Celltech suggested that the support a company could expect to receive from the City depended on its record in bringing profitable new products to market, or cutting costs by means of innovation in manufacturing techniques (P. 134). This explains the patient attitude which the City traditionally shows towards the pharmaceutical industry, whose record of profitability is well-proven (Q 751; p. 134). Sir Robin Nicholson also emphasised the importance of past record, and what an advantage innovative success in the past had been to Pilkington, in seeking support for innovation in the future (Q 1245). Of course this is of little comfort to new companies, or those whose products or processes have become obsolete. Such companies have the additional disadvantage of not being able to finance investment from the profits from previous successful products. The Fellowship of Engineering suggested too that "the City seems to understand large-scale businesses better than the smaller ones. Unfortunately, it is often at the smaller scale that many innovators operate" (p. 64).

5.10 A number of witnesses from the City stoutly defended their record. Kleinwort Benson said they "regard investment in innovation as imperative to the successful future of British industry . . . Accordingly when forming decisions on the merits or otherwise of the companies in which we invest we pay considerable attention to the management's attitudes in this respect" (p. 167). Barclays Bank plc made a similar point (P. 17). The Institutional Fund Managers' Association (IFMA) said there was "little evidence of a short-term bias in share prices" and evidence suggested "that financial markets react favourably to the announcement of corporate research and development programmes" (P. 156). The Prudential said they "look for companies which are essentially well managed and have good prospects for future growth . . . Our view on those investments has to be long-term" (Q 861) and "we do have a very strong relationship with the companies in whom we invest" (Q 869). A recent survey by Dr Alan Goodacre at the University of Stirling, under the auspices of the Economic and Social Research Council, suggests that City analysts do not penalise companies for their R&D expenditure but rather devalue firms that spend below the industry average.

5.11 Professor Paul Marsh, Professor of Management and Finance at the London Business School, recently published a report which roundly rejects suggestions of City short-termism.[2] He draws attention to the lack of hard evidence of a short-term bias in share prices, and says that suggestions of short-termism are based largely on anecdotal evidence of the behaviour of analysts and fund managers. He suggests that other factors are responsible for low levels of investment in the United Kingdom, such as a dearth of profitable investment opportunities, and the frequency with which industrial managers move from one company to another which makes them more concerned with short-term performance. With its language of crime, guilt, defence and prosecution, Professor Marsh's report demonstrates how high passions run when short-termism is discussed, and how vehemently arguments on one side and the other are deployed.

5.12 Sir John Harvey-Jones said of Professor Marsh that he "proves conclusively to his satisfaction that there is no such thing as short-termism; I am bound to tell you that he did not prove that to me" (Q 2182). He suggested that perceptions were all-important and that most British companies still perceived that they should aim at increasing dividends or risk being "marked down at a rate of knots" (Q 2205).

5.13 It may be that the negative City attitude perceived by industry is due at least in part to the lack of scientific or technological skills among financial analysts. British Steel said "many analysts have little knowledge of the basic technologies involved and therefore cannot apply any critical analyses to what they see and are told" (P. 79). Other witnesses echoed this view.[3] Significantly the Prudential has only one engineer on its analytical team (QQ 918-21). Kleinwort Benson was perhaps better equipped (QQ 957-61).

5.14 3i is a notable exception: a financial institution with staff with extensive industrial experience, and scientific or engineering qualifications, who are thus able to give proper assessment of propositions from certain business sectors (QQ 611-12, p. 104). This may at least in part explain the excellent reputation which 3i appears to enjoy among witnesses.[4]

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[1] See also QQ 1257, 1608.

[2] *Short-Termism on Trial*, a Report commissioned by the Institutional Fund Managers' Association, 1990.

[3] See for example Q 1037; p. 119; PP. 33, 110.

[4] See for example Q 426; P. 254.

5.15 Mr Peter Stormonth-Darling, of Mercury Asset Management Ltd., talked about short-termism in company management. He suggested that "in the remuneration of senior managers today there is a heavy element of annual cash bonuses which are tied to the results this year" and that this adversely affected priorities (Q 1933). Professor Marsh cited surveys which demonstrate the adverse impact on investment decisions of short-term incentives for managers and the beneficial effects of deferring performance-related compensation to the end of a fixed period.[1] Mr Kerridge on the other hand said "I find no problem in giving my managers very good and high bonuses for the short-term performance because at the very top I rely on their integrity not to chase short-term objectives in order to get this year's bonus if that will sacrifice the future" (Q 1468).

5.16 Some witnesses suggested that greater openness and communication between industrial managers and their investors would improve matters. The EEA for example said "companies could take more trouble to sell innovative ideas to the City" (P. 115).[2] The Prudential said that "correct evaluation of companies by the stock market does depend upon managements being reasonably forthcoming when describing their investment plans and future expectations" (p. 157) and suggested that companies might devote more space in their annual reports to discussion of R&D plans for the future and the fruits of R&D done in the past (Q 904). Glaxo has certainly found such efforts to be worthwhile (P. 139). Oxford Instruments, on the other hand, who make great attempts to explain their strategy to investors, have had a mixed experience (Q 1035). The IFMA interestingly suggested that better communications between the two sides could prevent "incorrect perceptions of City attitudes" giving rise to short-term responses on the part of industry (P. 156).

5.17 The disclosure of R&D spending in the accounts of public limited companies, as now provided for by Accounting Standard SSAP 13, should enable shareholders and City analysts in future to take a positive view of R&D spending in relation to turnover and to the spending of competitors. However some companies, particularly small ones, are still not subject to this standard, which is in any case not a legal requirement but only a requirement of good accounting practice.

TAKEOVERS

5.18 One of the manifestations of short-termism is a proliferation of takeovers. Although investment is capitalised, heavy investment by a company can affect profit rates until the returns on that investment come on stream. Companies fear that unfavourable reactions to such reductions—for example falling share prices or refusal of loans—make it difficult to withstand takeover bids. Obviously where a company is unprofitable because it is badly managed it may be appropriate for a takeover to occur and performance may thereby be improved. But where the takeover is made possible only because of a depressed share price due to long-term investment reducing short-term earnings, then it is unlikely to be in the best interests either of the acquired company or of British industry as a whole. Professor Porter said that "the British economy would be better served if takeovers occurred where there was evidence of pretty bad performance, not just a company that could be stripped of its assets" (Q 1208). He also suggested that while elimination of competition between two firms, by means of merger or takeover, might result in a short-term gain in efficiency, it might not be conducive to innovation (QQ 1210, 1212). Furthermore, when the DTI surveyed academic research on the subject in 1988 they found no evidence to suggest that post-merger performance was more efficient, and the evidence there was suggested "disappointing or inconclusive performance".[3]

5.19 A number of witnesses lamented the ease with which contested takeovers succeed. The Institution of Production Engineers suggested that "the City's preference for acquisition, rather than longer-term organic growth, is damaging to both company and country in the long term" (P. 154). Dr J L Leonard of Eurotherm International said "business has been badly damaged" by takeovers (Q 821) and that the fear of takeover could make a manager reluctant to invest adequately (Q 824). Sir William Barlow, Chairman of BICC plc and of the Engineering Council, spoke of the "constant looking over our shoulder wondering whether we will be the next to be the subject of a takeover . . . that is a constant concern" (Q 2162).

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[1] *Op cit*, pp. 53, 54.

[2] See also Q 963; p. 83.

[3] *Mergers Policy: A Department of Trade and Industry Paper on the policy of merger control*, HMSO, 1988. See Annex E, pp. 36-38.

5.20 Mr Lilley said "There does seem to be . . . in the market as a whole what I have called a deal culture, where there is an over-propensity to make deals and expand by acquisition; and spending a lot of time defending yourself against other people making acquisitions seems to predominate at the expense of the organic growth of the company" (Q 2279).

5.21 It has often been suggested that the threat of takeover serves as a desirable incentive to management which might otherwise become complacent or ineffectual. This may be so, but as was apparent on the Committee's visits abroad, it is by no means necessary. In Germany for example the close involvement of the banks, and the existence of a supervisory board, provided a check on management. In Italy, where many companies are secure from takeover because they have a private controlling shareholder who is unlikely to sell, there was no evidence that company managements were anything but vigorous, efficient and committed to innovation.

5.22 The institutional investors who gave evidence suggested that in any case takeovers are less prevalent than is feared by some companies and that they would usually prefer to support the incumbent management in the face of a contested bid where this was feasible and compatible with their duty to those whose funds they manage. The Prudential, for example, said "By philosophy, we are minded to support incumbent management where those managers have displayed a record of good management and good housekeeping" and that in 1989 they had voted with the company in 79 out of 84 takeover bids for companies in their portfolio (Q 871).[1] Kleinwort Benson made a similar point (Q 955), though they did suggest that a reduction in the threshold for mandatory takeovers from 30 per cent to 20 per cent "would provide company management with a bit more control over their own destiny" (Q 934).

5.23 A recent survey[2] of the levels of merger activity in Europe concluded that "the UK stands out as being the most merger active country in Europe". The United Kingdom accounted for 73 per cent of all mergers in the EC in 1988. The recent trend in acquisitions and mergers by industry in the United Kingdom, shown in Figure 21, reveals an increase in activity during the 1980s. Other countries in Europe have defences against contested takeovers (Q 2208). Sir John Harvey-Jones observed that the United Kingdom is "the only jungle in which predators from the continent can happily roam unhindered by anyone" (Q 2210).

5.24 It is sometimes suggested that institutional shareholders are too inclined to sell shares in a company which is doing poorly rather than attempting to initiate improvements. The Prudential however said that they were active in shaping companies and frequently took the initiative in discussing future strategy with managements, sometimes alone and sometimes in concert with other major shareholders. This was done quietly and without publicity, which management preferred (QQ 882-883). On the other hand the IFMA pointed out the limitations of such action. "Firstly, fund managers are not industrial managers; they are not qualified by training or experience to manage industrial companies and intervention in their day-to-day running would not only be resented by industrialists but be damaging. Secondly, fund managers' primary responsibility is to their clients and too great an involvement might prevent them operating effectively as fund managers" (P. 156). Mr Stormonth-Darling suggested that while the "voice, not exit" approach[3] was sometimes appropriate, it should be followed with caution because "the skills that make a good fund manager are simply not the same skills that make a good industrial manager" (Q 1919).

AVAILABILITY AND COST OF CAPITAL

5.25 The availability and cost of external capital are problems encountered by some companies in their attempts to innovate. Innovation requires investment in all or any of research, design, development, plant and equipment, marketing, training and skills. While such investment may not be difficult for a company with adequate profits, it can be an almost insuperable obstacle for a start-up venture, or a company attempting recovery from a weak base. The difficulties for small companies are particularly severe.

5.26 Witnesses' views on the availability of capital varied. The CBI found that "only 10 per cent of respondents believe that the availability of external finance is becoming more difficult".[4] Other witnesses also thought availability was not a problem.[5] But the Engineering Council regarded "the reluctance of banks to back innovation . . . as a considerable restraint to most small firms" (P. 120). The CVCP said "It is difficult to obtain 'seed-corn' finance for ideas" and complained that venture capital is usually only available in sums of £50,000 or more (P. 93). The frequent desire of venture capitalists to take an early exit from the investment was also a subject of complaint.[1]

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[1] See also p. 157.

[2] *Recent Patterns of European Merger Activity,* P A Geroski and A Vlassopoulos, in *Business Strategy Review,* Summer 1990.

[3] Whereby shareholders voice concern and initiate change, rather than selling their shares, when a company performs poorly.

[4] CBI Innovation Trends Survey, Issue 1, p. 8.

[5] See for example QQ 76-79, 1239.

5.27 Figure 22, which shows the composition of venture capital investment activity in the United Kingdom since 1984, reveals a substantial increase in the percentage of total investment devoted to the financing of buy-outs, buy-ins and acquisitions. The counterpart of this has been a reduction in the relative importance of start-up and other early stage and expansion projects.

5.28 Witnesses were generally in agreement about the inhibiting effects of the high level of interest rates in the United Kingdom compared to those in competitor countries. The Fellowship of Engineering said "the relative costs of borrowing in the UK do have a significant negative effect in terms of expenditure on machinery, systems and people. Inevitably this tends to hinder innovation in manufacturing industry" (p. 61). This point was repeated by many other witnesses.[2] The inability of a company to plan long-term investment strategy in the face of widely fluctuating interest rates was also remarked on. The CBI said it was necessary for interest rates not only to be reduced but to be stabilised as well (Q 199).

5.29 The Secretary of State said that high interest rates were "a necessary evil if we are to get inflation down" (Q 2283). He suggested that, although they might be expected to discourage investment, "it is up to management to get their priorities right and recognise that we are going through a short-term problem of getting inflation down. Investment and research and development are for the long term and it would be extremely unwise for anybody to sacrifice their long-term prosperity . . . because of short-term problems" (Q 2288).

5.30 The CBI identified the cost of capital as of critical importance (QQ 58, 200) and also found that it "is affecting smaller companies much more quickly than larger companies" (Q 193). BP suggested that "a significant problem for innovation within many British companies lies with the economic returns expected. Any project would normally be expected to have a real rate of return of at least 10 per cent. By contrast, many of our overseas competitors would be happy at 5 per cent or less over, say, a seven year lifetime and would take the strategic position for a later time frame into account . . . One result in the UK is frequently that to improve the financial position necessary resources are not devoted in the development stage" (P. 41).

5.31 A recent report by the Federal Reserve Bank of New York (FRBNY)[3] found that the real after-tax cost of funds was much greater in the USA and United Kingdom than in Japan and Germany (Figure 23). However, while the cost of funds a borrower faces is the same for all projects, the cost of capital is subject to influences[4] which vary with the type of investment in different ways across countries. Figures 24 and 25, which compare the estimated cost of capital for two different types of project, reveals that Japanese and German firms have benefited from a lower and more stable cost of capital throughout the 1980s than firms in the United Kingdom or USA. Furthermore the required rate of return for an R&D project (Figure 25) illustrates how a relatively high cost of funds acts as a deterrent to investments with longer pay-back periods.

5.32 Other witnesses identified difficulties because of unstable exchange rates.[5] Edwards High Vacuum explained the costs that the company incurred when rates shifted (QQ 1882, 1883). The TUC said that "fluctuating exchange rates discourage R&D. Uncertainty about future competitiveness in export markets discourages risk taking" (P. 273).

TAX AND ACCOUNTING

5.33 Witnesses raised three different points about tax and accounting: the treatment of R&D for taxation purposes; the treatment of capital expenditure for taxation purposes; and the accounting practice of firms. We deal with each point in turn.

5.34 A number of witnesses argued that tax incentives for companies to encourage investment in R&D should be introduced by Government. At present 100 per cent of R&D expenditure can be written off before calculating taxable profits, but witnesses suggested that positive tax allowances (that is, of more than 100 per cent) would provide a greater spur to companies. BP said "tax concessions on R&D expenditure represent the most direct and valuable support Government can give to innovation" (P. 43). Others supported this view.[1] Sir John Harvey-Jones said that we could not play on a level playing field with our Japanese competitors without the same incentives which they enjoy (Q 2211).

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[1] See for example PP. 154, 284.

[2] See for example QQ 746, 975, 1256, 1933; p. 134; PP. 120, 122, 237, 269.

[3] "Explaining International Differences in the Cost of Capital", Federal Reserve Bank of New York, *Quarterly Review*, Summer 1989, pp. 7-28.

[4] In particular the tax treatment of depreciation and investment credits.

[5] See for example PP. 74, 237; Q 2226.

5.35 Not all witnesses favoured such incentives. Sir Geoffrey Allen said "the company has to have the enthusiasm and will to see it [R&D] through. I think fiscal encouragement to do it leads to more disaster" (Q 1788). Glaxo too were content with the current regime but complained of the action of local tax inspectors, who they said were "seeking to re-define R&D, without any apparent instruction from Government, by splitting research from development, effectively removing tax relief from capital spent on development" (P. 140).

5.36 An international survey[2] by Inland Revenue and HM Treasury was cautious about the effects of fiscal incentives. It concluded that "the best evidence available suggests that special fiscal incentives increase industrial R&D by an amount that is roughly one-half of the revenue forgone by the Government: the remainder goes to swell companies' cash flow and post-tax profits". It also noted that abuse had in some cases led to "the discontinuation or substantial modification" of measures.

5.37 A survey[3] of the 150 per cent tax concession for R&D spending introduced in Australia in 1985 found that private BERD had accelerated since the introduction of the concession and that the expenditure on R&D of those firms registering for the concession increased at a more rapid rate. While acknowledging that this large increase in R&D could not be attributed to the tax concession alone (other factors included changed accounting procedures and natural growth) the survey concluded that the concession had had a "positive role" in promoting R&D. In their evidence the Inland Revenue (P. 151) stated quite categorically that "the Australian Bureau of Industrial Economics (ABIE) found that the relief had cost the Australian taxpayer Aus $4 for every Aus $1 of new spending on R&D." This was indeed the case but the ABIE emphasised that this finding was not conclusive because no allowance was made for Government claw-back through the imputation system and as a result conventional estimates may well significantly overstate the revenues forgone under the concession. Moreover the ABIE concluded that such a result did not necessarily mean that the tax concession was cost-ineffective as the concession was seeking to raise permanently the level of business R&D, and its value lies not in the expenditure on R&D itself but in the increase in innovation that would result from the R&D.

5.38 The FRBNY have noted that tax credits can lower the barrier to investment in longer-term projects. They suggested that without tax credits for R&D of 20 to 25 per cent in the USA and Japan, the cost of capital for such projects in the USA would have been closer to the cost in the United Kingdom and that in Japan would have been closer to that in Germany (see Figure 24).[4]

5.39 Another feature of the tax regime which could influence the rate of innovation in a company is the system of capital allowances by which expenditure on machinery and plant in the United Kingdom may qualify for tax relief. Until 1984 most expenditure on machinery and plant qualified for immediate 100 per cent first year allowances. Since then expenditure has been depreciated on a 25 per cent reducing balance basis. According to Inland Revenue, this reduction in rates of allowance was "to bring them more closely into line with commercial depreciation". It was also intended to rectify the situation whereby high rates of allowance "could distort investment decisions and encourage poor quality investment" (P. 148).

5.40 Withdrawal of 100 per cent first year allowances, although offset by reductions in corporate taxation rates, has had implications for companies' cash-flow. A number of witnesses agreed that a return to a more generous system of capital allowances, with accelerated amortisation at a rate chosen by the individual company, would increase cash-flow and lessen the inhibiting effects of the high cost of capital. The TUC for example said, "By increasing the amount of capital spending that firms can offset against taxation in any one year the effective cost of capital would be less and it would help offset the adverse effects of high interest rates on investment" (P. 271). Mr Stormonth-Darling said that institutional shareholders "would be delighted" by such a change, which would be a spur to investment (Q 1936).[1] However it should be noted that for assets with a long economic life the change would not be advantageous.

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[1] See pp. 64, 119; PP. 14, 76, 93, 97, 129, 273, 284; Q 1936.

[2] *Fiscal Incentives for R&D Spending: An International Survey*, Inland Revenue and HM Treasury, March 1987.

[3] *The 150 per cent Tax Concession for Research and Development Expenditure—Interim Report*, Australian Bureau of Industry Economics, 1989.

[4] Federal Reserve Bank of New York, *Quarterly Review*, Summer 1989, p. 16.

5.41 Mr Lilley pointed out that the removal of 100 per cent first year capital allowances had coincided with a progressive reduction in the rate of taxation from 52 per cent to 35 per cent. He also suggested that such allowances had encouraged "investment for fiscal rather than industrial reasons" and that "since the change we have seen investment being much more orientated towards the productive needs of a company rather than the whims of the finance director" (Q 2326).

5.42 The CBI in *Investing for the New Decade*[2] proposed an increase in capital allowances to 40 per cent reducing balance. They argued that United Kingdom business paid a higher proportion of GDP in taxes on corporate incomes than business in West Germany, France or the USA. They also argued that 25 per cent reducing balance was inadequate given the rapid advance of technology and the resulting shorter economic lives of many assets. Furthermore they showed that, despite reductions in rates of corporate taxation, total revenue from such taxation had increased as a result of the abolition of 100 per cent first year allowances.

5.43 Company accounting practice was also thought to be inimical to innovation. Professor Porter said, "much of the investment needed to innovate is not treated as an asset, because it has to be written off as an expense. You can spend hundreds of millions of dollars training your employees but it is not viewed as an asset on your balance sheet; you can spend hundreds of millions of dollars doing R&D, it is not viewed as an asset on your balance sheet" (Q 1205). A recent report spelled out the problem: "A preference for precise valuations of assets which can be objectively measured, while ignoring significant assets which are more difficult to measure, damages the usefulness of financial statements".[3] Mr McHugh suggested a solution: accounting practice should "recognise the value of investment in innovation in corporate balance sheets . . . This would require a recognition of the value of technology built up both in hardware and in the expertise of engineers and scientists. It would also require new methods to trace the use of technological assets so as to be able to match them against future earnings" (p. 81).[4]

5.44 **To sum up, the following main points are apparent from the evidence:**

(a) "Short-termism" is perceived to be a problem, for which the financial and industrial communities blame each other.

(b) Among financial analysts scientific and technological skills are scarce.

(c) The ease with which takeovers can occur is perceived to be a problem, and no evidence was adduced to suggest that they or the threat of them necessarily improve performance.

(d) High and fluctuating interest and exchange rates inhibit long-term planning.

(e) Changes in taxation and in accounting practices could promote innovation.

CHAPTER 6 MANPOWER

6.1 The ability of a company to innovate obviously depends on the skills, experience and motivation of its management and workforce. The Committee has not considered in detail the education and training needs of industry, or how well they are met by the current system. This was for several reasons: first because the subject is so vast that it should not properly be tacked on to another subject; secondly because in 1984 we published a report on *Education and Training for New Technologies*,[5] and thirdly, because the Advisory Council on Science and Technology (ACOST) are currently considering the matter. However manpower seems to be an area in which the United Kingdom is at a sorry disadvantage compared with some competitor countries and a number of witnesses cited trained manpower constraints as a serious obstacle to innovation. It is therefore appropriate for us to consider the evidence we have received.

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[1] See also QQ 1660, 2010, 2047; P. 122.

[2] *Economic Priorities for 1990*, CBI, January 1990.

[3] *Intangible assets: their value and how to report it*, Coopers & Lybrand Deloitte, March 1990, p. 5.

[4] See also Q 471; P. 83.

[5] Second Report, Session 1984-85, HL Paper 48.

6.2 The Engineering Employers' Federation clearly set out the need. "Successful innovation now more than ever depends on drawing on the brainpower of all employees. Education must establish in all young people a learning culture and a readiness to initiate as well as to accept continuous change" (P. 122). ICI said "the future of innovation in the chemical industry . . . depends on the education of our young people in science and engineering. Successful innovation comes from well-trained minds" (P. 145). At present this need is by no means met: a survey by 3i showed that 53.7 per cent of the companies questioned regarded the low level of staff education, training and skills as a "very important" obstacle to technological innovation (p. 103). A recent survey[1] reported that 60 per cent of engineering firms and 48 per cent of other production firms had experienced recruitment difficulties at some time during the 12 months prior to the survey. Of particular relevance to innovation, 37 per cent of firms overall felt that their business development opportunities had been severely limited as a result.

6.3 The proportion of GDP spent on education in the United Kingdom is comparable to that spent by our competitors (Figure 26). However, the proportion of people participating in education and training after the school-leaving age is low (Figure 27). Furthermore a large proportion of school-leavers have a lower level of qualifications than their counterparts in France and Germany (Figure 28).

6.4 The Fellowship of Engineering said that the shortage of skilled manpower at all levels was "one of the main reasons that we cannot expand as fast as we would like to" (QQ 434-36). Cambridge Instruments said it was "considerably harder" to find highly skilled staff in the United Kingdom and that they were often not so appropriately qualified as those in other countries in which the company operates (p. 93). ABPI said that "the reason why, historically, so much innovation in the [pharmaceutical] industry has come out of the UK is that there has always been an available pool of high quality scientists. There is a danger that this pool is getting smaller" (P. 9). Dr D R Winterman, Process Development Director of Smithkline Beecham, said "We are increasingly finding it difficult to get scientists of the right calibre" (Q 1312).

6.5 Inevitably, the problem begins in schools. Mr Kynaston of Philips Components said "the broad educational standards are inadequate. Our educational system is embarrassing if you compare my raw material with that of my colleagues around Europe" and suggested that even general levels of literacy and numeracy were poor (Q 1998). ICI said "the sciences and engineering . . . are not widely or well enough taught in British schools . . . the number and quality of science teachers decline; so does the number of school leavers wanting to follow a scientific career" (P. 145). Mr Kerridge, of Fisons plc, said that "good calibre students . . . particularly at the secondary level are discouraged still from thinking of industry as a career" (Q 1463). The Engineering Employers' Federation welcomed the National Curriculum as "a significant step in the right direction". However, they warned of the need to devote adequate resources to its implementation, including the necessary teacher training, and to raising targets once initial objectives have been met (P. 122).

6.6 In higher education there are difficulties too. The Royal Society of Chemistry warned: "if, because of a lack of support for basic, fundamental chemistry research in our universities and polytechnics, the supply of key people to the UK chemical industry becomes constricted, companies will be forced to do more of their research abroad" (P. 263). The same is no doubt true of other scientific and technological disciplines. The Engineering Employers' Federation noted that "demand for engineering graduates continues to outpace the supply" (P. 123).

6.7 Some specific skills are in short supply. Witnesses quoted computer programming, microprocessor engineering, information technology and production engineering (QQ 326, 1650, 1875; PP. 13, 114, 144).

6.8 Both the Engineering Employers' Federation and British Aerospace commented on the acute shortage of properly trained technicians and support staff. They suggested that this resulted in inefficient use of graduate manpower which in turn led to demotivation and high rate of turnover (Q 678; P. 123). British Aerospace noted the much greater numbers of technicians and craftsmen available in Japan and Germany (Q 680).[2] Certainly in Germany we found that the availability of adequate numbers of highly-skilled technicians was widely regarded by industry as a strong competitive advantage.

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[1] *Skill Needs in Britain*, IFF Research/Training Agency, 1990.

[2] See also QQ 1800-1802.

6.9 The difficulties of skills and training are said to extend to management as well. Professor John Bessant of Brighton Business School explained: "the general level of formal qualification amongst UK management is very low. For manufacturing industry this is even more serious because the majority of those few managers who do have a formal qualification have been trained in general management (for example on MBA[1] courses) which tends to emphasise financial and marketing aspects at the expense of manufacturing or technology. The consequence is that . . . the UK is reliant on a relatively unskilled and unqualified group of managers" (P. 33). He argued for an increase in the provision of "education in technology management".

6.10 Sir William Barlow observed that there had been a great improvement in the quality of management in recent years, partly as a result of increased training. He urged the importance of continuing education and training throughout a career (Q 2143). Sir John Harvey-Jones observed that in his experience British management "is under-trained, it is under-professional, it is damned hard working and well intentioned, but it is not recruited from the brightest and best in our country" (Q 2199).

6.11 Sir Robin Nicholson said that business schools had in the past done little to strengthen the technological understanding of the next generation of British industrial managers but that the situation was beginning to improve (Q 1244). Professor Tom Cannon, Director of the Manchester Business School, gave a clear overview of recent initiatives taken in a number of HEIs throughout the country, with new degree courses at both undergraduate and post-graduate levels and cross-fertilisation between business schools and departments of engineering and science (PP. 222-4).[2] But he emphasised that most of these initiatives are small, "virtually all are under-resourced" and there is "a lack of any significant interest among policy makers".

6.12 Training by companies has an important role in countering the skills shortage. Many companies—for example British Aerospace (Q 681), Lucas Industries (Q 1677), GEC (QQ 1651, 1652), Edwards High Vacuum (Q 1874)—are making substantial efforts in training but too many companies do not. A recent survey[3] found that only 33 per cent of employees in manufacturing industry received any training in 1987, compared for example with 60 per cent in the public sector. Lord Weinstock remarked that "A company like GEC necessarily makes a contribution to the stock of skills in the country for use by other people" (Q 1652). Mr F D Rosenkrantz, of Edwards High Vacuum, had a similar complaint: "because other companies know we train well we are a bit of a honey pot" (Q 1875).

6.13 Companies are increasingly trying to ensure the relevance of education to their own needs by making an input to the content of university and polytechnic courses, funding teaching posts, and by other means. Lucas Industries, for example, has sponsored twelve professorial posts in manufacturing systems engineering (Q 1680). Philips Components provide "real examples of failure and success for university courses which are exercised through projects" (Q 1995). At the University of Warwick, the content of the Integrated Graduate Development Scheme founded by Professor Bhattacharyya is worked out in conjunction with participating companies and much of the material is taught by them (Q 1492). Fisons plc provide industrial sabbaticals for teachers, "in order that they may go back and talk with some authority about the sort of careers that people get in industry" (Q 1466).

6.14 **To sum up, skills shortages are a problem at all levels in manufacturing industry. Companies are however paying increasing attention to both in-house training and support of the educational system.**

CHAPTER 7 THE ROLE OF GOVERNMENT

7.1 Government has an important role to play in promoting innovation. There is a distinction between Government intervention in industry and Government support for industry. The latter might be shown through the regulatory environment which it creates, its support of the educational system and the science base, its policies over taxation, standards and trading conditions, its demands as a major purchaser of goods and services, or its schemes of targeted assistance to industry. None of these need involve intervention in the way industry orders its affairs.

7.2 DTI said "the Government's main role is to create a climate within which successful innovative companies can flourish: it is for companies themselves to take the lead in developing innovative applications in their products and processes and also in their management" (p. 37). However they also acknowledged that "reliance on the decisions of firms may produce inadequate innovation for the maximum benefit of the economy" (p. 38).

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[1] Master of Business Administration.

[2] See also QQ 512, 513.

[3] Training Agency Funding Study 1989.

The appropriate level of Government activity

7.3 Implicit in much of the evidence presented to the Committee was the conviction on the part of industry that Government did not prize manufacturing very highly. This is not surprising given some of the statements made during the 1980s. Recently Government has shown some measure of recognition of the importance of manufacturing to the prosperity of the United Kingdom,[1] but of course old hurts will take time to heal. The Fellowship of Engineering said "we would like the British Government to take as much intelligent interest in our manufacturing industry as some of our competitor countries enjoy" (Q 411). The CBI said "anything the Government could do . . . to encourage that belief [that manufacturing is "a good thing"] would be helpful. We still have the legacy of the many years when manufacturing was thought not to be a prestigious thing to do" (Q 204).[2] Sir William Barlow said "there is a lack of national will, national pride, about innovation in manufacturing industry, and there is precious little interest and encouragement from the Government" (Q 2129). He went on: "the absence of national and government interest in . . . manufacturing industry, let alone innovation, is in my view a handicap . . . not borne by our main competitor countries" (Q 2136).[3] Sir John Harvey-Jones urged that Government decisions should be made on the basis of a better understanding of "the conditions that are needed for industry to thrive" and that DTI should be more regularly consulted about the likely impact on industry of policies formulated by other Government departments (Q 2230).

7.4 A number of witnesses thought that Government should be more active in its support for industry than was the case in the 1980s. The Society of British Aerospace Companies said "the lack of a Government industrial policy, beyond the belief in market forces, is harmful to the prospects of innovation in manufacturing industry" (P. 268).[4] Others suggested particularly that such a "hands off" attitude put the United Kingdom at a disadvantage *vis-a-vis* competitor countries whose governments were more proactive.[5] Cambridge Instruments drew attention to the support for product development received for some time by their German plant, while their "UK operation receives virtually no Government funding and the schemes that there are are directed away from product development" (p. 93). On our visit to Germany, we were struck by the amount of support and direct financial assistance available to companies from a multiplicity of sources, both Federal and Länder. Support was given to innovation projects selected by industry and we saw no evidence that government there attempted to "pick winners" nor that it detracted from the enterprise and efficiency of companies.

7.5 The perception of witnesses that manufacturing industry in competitor countries receives more government support than in the United Kingdom is borne out by European Community statistics. For the period 1986-88, average state aids to manufacturing (excluding steel and shipbuilding) as a percentage of gross value added were 6.5 in Italy, 3.5 in France, 2.7 in Germany and 2.5 in the United Kingdom. For the same period, average state aids to manufacturing in ECU per employee were 3,136 in Italy, 1,456 in France, 1,135 in Germany and 806 in the United Kingdom.[6] It is not possible however to determine how much of this expenditure assisted innovation.

7.6 Dr R P Oakey, of the Department of Business Organisation at Heriot Watt University, suggested that small firms in particular were disadvantaged by the absence of a more proactive Government policy towards manufacturing industry in the United Kingdom. He said that in the 1980s "the general trend in industrial policy towards manufacturing industry at national and regional levels has been a retreat from industrial planning, in favour of a free market approach . . . such a neglect of high technology small firms by Government . . . has created a poor environment for innovation and growth in small firms, while those few firms that have shown signs of reaching large size were acquired by foreign competitors in the absence of any British state or private sector support" (P. 238).

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[1] For example the Secretary of State for Trade and Industry said in evidence "I certainly cannot imagine a healthy British economy without a vigorous and successful manufacturing sector" (Q 2240).

[2] See also QQ 158, 159, 1404, 2004; P. 110.

[3] See also QQ 2141, 2155.

[4] See also p. 119; Q 724.

[5] See for example PP. 76, 109.

[6] *Second Survey on State Aids in the European Community*, Commission of the European Communities, July 1990, p. 10.

7.7 Other witnesses commented on the absence in the United Kingdom of any body charged with the remit of formulating a "long-term technical policy in key areas" as is done by MITI in Japan (p. 63). Dr Parnaby said "I see Government having a part to play in a national manufacturing strategy framework" (Q 1697). The achievements of MITI are very highly regarded in Japan. Delegates to the Fifth Anglo-Japanese High Technology Industry Forum told us that MITI's support is particularly appreciated by industries in leading-edge technologies. Together with industry, MITI draws up "vision papers" identifying areas likely to be of strategic importance in future and provides finance on a shared-risk basis to encourage start-up activity. Support is withdrawn once a venture becomes self-sustaining, and the early vision and encouragement have borne fruit. BP urged that Government in the United Kingdom should play its proper role in "establishing and utilising major generic technologies". They said that governments elsewhere were more active in identifying and funding technologies likely to be of future importance, such as advanced composite materials and photovoltaic energy systems (P. 42).

7.8 Only a few witnesses did not urge a greater level of Government activity in industrial support than is apparent at present. Glaxo said "all that we ask is that obstacles are not placed in our way and that we can compete on a level playing field with our international competitors from Japan and the USA" (P. 139). Sir Robin Nicholson began by suggesting that it is "much more likely that Government . . . will interfere with the innovation process than that it will promote it by actions that it takes" (Q 1234). However, he went on to acknowledge that in a number of cases—"recovery, very large projects and small companies"—market forces might not be sufficient to prompt adequate innovation (Q 1236). Sir Charles Carter lamented Government's "propensity to meddle" (P. 86).

7.9 Mr Lilley identified three broad areas in which Government support for industry was appropriate. First, "where research is distant from the market . . . it is particularly likely that not enough of it will be undertaken and Government should help". Secondly, "in certain high risk collaborative projects perhaps the Government should help" and thirdly "smaller companies often do not have background knowledge and expertise to fund research, and so we give an additional boost" (Q 2256). He also said "the main concern of Government must be to ensure profitability of British industry and that they have that basic incentive to carry out the investment themselves" (Q 2276).

THE NEED FOR STABILITY

7.10 The present Secretary of State for Trade and Industry is the seventh since the two areas of responsibility were brought together in June 1983. Programmes of support and assistance have come and gone only slightly less frequently. This inconsistency was criticised by a variety of witnesses, who commented on its damaging effects on industry. Sir Charles Carter said "a major problem is the propensity of Government . . . to create uncertainty and extra work by frequent initiatives or changes of policy. A stable environment, free of stop-start policies, changes in the regulatory system and great fluctuations in interest rates or exchange rates, allows management the opportunity for long-term thinking" (P. 86). Lord Weinstock said "Anything that makes for instability is hostile towards long-term expenditure of one sort or another, and particularly organised methods of encouraging innovation" (Q 1607). A CBI survey has recommended that "DTI schemes should be subject to less rapid change than in the past".[1] The CVCP said "frequent changes in policy and personnel [of Government Departments] militate against familiarity to industry which is essential if schemes are to be effective" (P. 93). Cambridge Instruments confirmed this (Q 521). Eurotherm International warned that too frequent change "is the worst thing about the whole situation, from our point of view. We need stability" (Q 794).

DTI SCHEMES AND SUPPORT[2]

7.11 Sir William Barlow observed that the first requirement if Government is to play a more active part is a department charged with responsibility. He said the industrial section of DTI "is being deliberately run down" (Q 2132) and "is being dismantled in a cynical, rapid, throwaway fashion" with a marked reduction in staff (Q 2155).

7.12 Other criticisms, particularly about the operation and performance of the DTI, were numerous. A common complaint was that procedures are long-winded and obscure. The

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[1] *Technology and Enterprise: A CBI review of DTI support for technology in industry*, 1990, p. 7.

[2] A review of DTI expenditure during the period 1981-88 is printed as Appendix 4. The DTI described their activities in written evidence, pp. 37-42.

Engineering Council said "insofar as support is available it has become such a bureaucratic maze and art form that only the larger companies, who are able to devote the time and effort necessary, can benefit from it" (P. 119). The Institution of Production Engineers said that DTI schemes "involve excessive negotiations and subsequently require a high level of reporting. These problems are seen to result in projects that move too slowly, and give little support for real innovation" (P. 154). Other witnesses made similar points, as well as criticising the level of resources deployed by the Department, their effectiveness and their organisation.[1] Professor J M Owen, from the School of Mechanical Engineering at the University of Bath, had a sorry tale to tell of protracted negotiations, conflicting signals and eventual disappointment in his dealings with DTI (PP. 240, 241).

7.13 Some witnesses regretted the abolition of Support for Innovation (SFI), the scheme under which single companies could obtain support (usually 25 per cent of eligible project costs) for R&D right up to the design, development and launch of new products or processes. The Food and Drink Federation (FDF) for example said, "it is regrettable that the DTI Support for Innovation schemes were lost as these positively helped innovation" (P. 129).[2] Cambridge Instruments cited product developments which were made possible by SFI, and said, "without these products the company would not have survived" (p. 93). Oxford Instruments suggested that the present requirement of collaboration, in projects for which DTI funding is sought, was "a great inhibition" (Q 1050).

7.14 Other witnesses recalled the Research Requirements Boards, by which applications for funding under SFI were assessed. Professor Sir Hugh Ford said "the Requirements Boards were excellent and should never have been discarded. The results of their grants were far reaching and profitable" (P. 131). The Fellowship of Engineering said it was "a pity that they disappeared . . . What has been left we feel on the whole has been far less effective" (QQ 395-396).[3] Sir William Barlow suggested that the strength of the Boards lay in their membership of "outside experts" (Q 2138).

7.15 The DTI explained the shift away from these popular programmes. "The majority of industry believes it is better to put public money into the science base than to use it for product and process development" (Q 263). "One of the reasons for not continuing with single company support as in the past is that a significant proportion was going to large companies . . . and did not actually add to the amount of R&D done in the country" (Q 273). On the other hand Sir William Barlow said that Government funding "causes things to happen that would not otherwise have happened . . . there has been in the past in my view positive progress made as a result of some of the Government schemes that used to be in position" (Q 2140).

7.16 Mr Lilley explained to the Committee three new schemes to assist SMEs, which he expects to launch early in 1991. One of them, SPUR,[4] will provide single-company grants for product and process development and so goes some way to meet the complaints of witnesses about the demise of SFI. The other two schemes will assist in providing external technology assistance and advice to companies. The three schemes together will be worth £30 million over three years (Q 2289).

7.17 Mr Pilditch regretted that current DTI support schemes are restricted to firms with fewer than 500 employees: "it means larger companies fall outside Government schemes. To suppose they should be able to look after themselves ought to be right, but isn't" (P. 252).[5] Mr McHugh on the other hand regarded the weighting of support towards SMEs as "dogmatic rather than pragmatic" as, although SMEs face unique difficulties, pump-priming money from DTI would be more likely to facilitate overall increases in spending on innovation in large companies than small (p. 81). He said "if we think of the nation as a whole therefore it may well be wiser to encourage investment in larger firms because pound for pound we would get a better return" (Q 504). However there is evidence that SMEs can play an important role in national rates of innovation and in the emergence of new technology-based sectors and they do face particular difficulties.[6]

7.18 The effectiveness of launch aid as a method of industrial support was attested by British Aerospace. Mr Yates said "without that over the last few decades, then there would not be, I believe, a civil aviation industry [in the United Kingdom] in terms of either aeroplanes or engines . . . launch aid is a very effective mechanism" (QQ 668, 676). In view of this it is of interest to note that aerospace is one of very few sectors of United Kingdom manufacturing industry in which there is a positive balance of trade.

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[1] See for example pp. 63, 81, 284; QQ 404-407, 410, 1382; PP. 13, 75, 92, 97, 104, 129.

[2] See also p. 222; PP. 71, 284; QQ 1376, 2132.

[3] See also Q 2133.

[4] Support for Products Under Research.

[5] See also P. 75.

[6] See for example R Rothwell (1989), "Small Firms, Innovation and Industrial Change", *Small Business Economics*, Vol. 1, No. 1.

7.19 Mr Lilley said that the aerospace sector was a very special case. Launch aid was appropriate because development in the industry was very lengthy and absorbed huge sums of money, and because there was a risk of monopoly by foreign suppliers. He did not see similar special need in another sector (QQ 2303, 2304).

Near-market research

7.20 The Government's withdrawal from near-market research was widely thought to be damaging to the national interest. The ECIF explained: "current concentration on support only for pre-competitive research ignores the fact that a crucial stage in the innovation process is the translation of research and development into 'economically significant applications'; this is vastly more expensive than R&D" (P. 110).[1] British Aerospace said "in the United Kingdom we are reasonably strong in research but it is the very area of development and nearer market investments where we fall down" (Q 675).

7.21 The situation is worst for SMEs. Professor J S Metcalfe, of the Department of Economics, University of Manchester, said "current Government innovation support policy, with its emphasis on collaboration and 'far from market' scientific development, is contrary to the needs of smaller firms. This policy fails to address the risk factor in innovation which is a major consideration limiting the ability of smaller firms to innovate" (P. 226).[2] The damaging impact on SMEs may be lessened by the introduction of SPUR (see paragraph 7.16 above).

7.22 The EEA suggested that manufacturing systems were particularly threatened by Government policy on near-market research and that our competitors were more active in this area. "This policy has been interpreted in such a way as to rule out much of the research on production techniques on the grounds that "production" is "near-market". In fact, some research on production techniques may bear fruit only after ten years or more" (P. 114).

Technological information from overseas

7.23 An area in which witnesses felt they did not receive as much support and assistance from Government as their competitors in Japan was identifying and acquiring technology from overseas. The Japanese have agencies with a formal remit to monitor the technological achievements of the country in which they are based and to report on them to Japanese manufacturers—a kind of "talent spotting" which assists Japanese companies to acquire new technologies from wherever they emerge. The United Kingdom, by contrast, has very few staff overseas specifically charged with this activity. Some Science Counsellors (based in only five of our Embassies) perform something of this function, as do some of the economic and commercial staff, but it is in addition to their other duties and is by no means a systematic exercise. The Fellowship of Engineering (p. 65) and the Engineering Council (P. 120) both urged an expansion and proper organisation of resources devoted to this. Witnesses suggested that Government should play a more active role in disseminating marketing and technical information and assisting companies in dealing with foreign regulatory regimes, for example in intellectual property rights.[3]

7.24 The DTI runs a scheme which enables British experts to travel overseas to improve the flow of information about foreign technology. There were 70 such missions between 1986 and 1990 (p. 40). Mr Lilley described other assistance given. He suggested that the role of Government was not to meet the needs of individual companies but "to raise the awareness of the value of overseas technology and technological information in UK industry" (Q 2324).

Regulations and standards

7.25 The regulatory regime established by the Government—including quality standards and environmental targets—will have an effect on the levels of innovation to which companies commit themselves. The Fellowship of Engineering noted that "there are occasions when legislation actually stimulates innovation and it is certainly the case that many developments have come about as a result of trying to meet increasingly stringent regulations" (p. 65).[1] 3i said that regulations "do not appear to inhibit those companies or individuals committed to innovation" (p. 104). By contrast ICI cited the recent measures to regulate biotechnology as showing the damage which could be done by hasty or ill-informed regulation (P. 146). The CBI Innovation Trends Survey suggested that firms of all sizes are increasingly concerned about the effect of standards on their business. Sir Robin Nicholson remarked on the difficulty and cost, for a company seeking to be internationally competitive, of meeting different standards for different markets. He urged the DTI to continue its efforts to improve the position, by seeking more widely-accepted international standards (Q 1271). Internationally-accepted standards are of course of particular benefit to United Kingdom companies, which have such a small home market.

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[1] See also QQ 495, 496; P. 3.

[2] See also P. 101.

[3] See for example PP. 9, 39, 120; *CBI Innovation Trends Survey*, Issue 1, p. 7.

SUPPORT FOR THE SCIENCE BASE

7.26 Some witnesses expressed concern at what they saw as Government's failure to ensure the strength and stability of the science base. Glaxo spelled out its demands of higher education: "to provide well-educated, skilled and adaptable staff, to encourage the study of scientific and technological subjects and to carry out basic scientific research" (P. 141). But they spoke of a "failure of the infrastructure" and felt that too great demands were being made of industry to make good that failure by financial support. Other witnesses expressed similar views. The ABPI for example was "concerned that the Department [of Education and Science] is failing to respond to the rate at which the scientific world is moving and the increasing costs required to fund this progress effectively" (P. 9).[2] The CBI said that while industry had a role in support of the science base, the prime responsibility lay with Government (Q 143).

7.27 **To sum up, the following points emerged from the evidence:**

(a) **Governments in competitor countries are more active in support of industry—for example in near-market support, assistance with technological information from overseas, support for SMEs—than Government is in the United Kingdom, and this disadvantages United Kingdom industry.**

(b) **Instability and frequent changes in Government support schemes are damaging.**

(c) **Present DTI support schemes are on the whole not well regarded.**

(d) **Well-researched, internationally-agreed standards can stimulate innovation.**

CHAPTER 8 THE ROLE OF THE EUROPEAN COMMUNITY

8.1 The European Community (EC) plays a significant role in promoting innovation, with a variety of schemes and programmes supporting collaboration in different fields. Initiatives such as ESPRIT,[3] RACE,[4] and BRITE/EURAM[5] help to strengthen European technological capability in world markets, and thus perform a notable strategic role. The DTI said "there has been considerable growth in EC R&D in recent years and the value of support for collaborative R&D obtained by United Kingdom manufacturing industry through EC programmes is as great as that from DTI programmes". They also noted that "UK organisations secure just over 20 per cent of the total funding available . . . and actively participate in between 50 per cent and 80 per cent of the projects" (p. 39).[6]

8.2 Some witnesses commented favourably on the activities of the EC in this area. BP said that their experience had been "generally positive" (P. 43). The EEA said "British companies involved in such programmes . . . are generally considered to have gained by their involvement" (P. 116).[7]

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[1] See also P. 270.

[2] See also PP. 89, 130.

[3] European Strategic Programme for Research in Information Technology.

[4] Research in Advanced Communications in Europe.

[5] Basic Research in Industrial Technologies for Europe/European Research in Advanced Materials.

[6] The EC's R&D framework programme, under which more programmes operate, was described in *A Community Framework for R&D*, European Communities Committee, 17th Report (1989-90) (HL Paper 66) which was debated in the House on 28 January 1991.

[7] See also PP. 40, 108.

8.3 But more witnesses expressed dissatisfaction with the operation of EC programmes. The main complaint was of problems of access. The Institution of Production Engineers said that "Excessive EC bureaucracy deterred all but the largest companies from completing negotiations and participating in EC schemes" (P. 155). BP, BEAMA and the CIA all said that applications were very time-consuming and that this was a disincentive (PP. 43, 90, 127). Other witnesses echoed these points.[1]

8.4 Some witnesses suggested that large firms were able to benefit from EC support but that the difficulties for SMEs were considerable. Dr C E Webb described the problem clearly: "While big companies can afford to have departments staffed with employees whose sole business is to write proposals for Brussels and to keep themselves informed about the availability of funding for new projects, very few small companies and universities can afford such a luxury" (P. 285). 3i said they were "aware of few opportunities for the smaller company, which finds significant difficulties in benefitting from them" (p. 104).[2]

8.5 Additional criticism of EC programmes included that the emphasis on collaboration resulted in expenditure on areas of research which were too general to warrant industrial support (p. 213). It was also suggested that "a net out-flow of technology and innovation from the UK" could be damaging (P. 98).[3]

8.6 Several witnesses felt that, with a little help from Government, United Kingdom industry could benefit more from EC programmes. Dr Derek Roberts, Provost of University College London and former researcher director of GEC, suggested that the situation might be improved "(i) By giving the impression that the UK is a positive participant in EC programmes, not a permanent critic; (ii) By having national policies and programmes which complement EC programmes—as do our competitors" (P. 263).[4] The FDF also believed that "in some other European countries (e.g. France, Belgium, Eire) it is the national government which supplies all or part of the balance of funds rather than the industry itself" and that "support might also be given to companies in their efforts to apply for EC funding" (P. 130).[5] BP suggested that Government should disseminate information about programmes and potential collaborators, so that United Kingdom companies would be better placed to involve themselves (P. 43). The DTI does produce and distribute literature aimed at increasing the involvement of United Kingdom companies in EC programmes, but no witness referred to it.

8.7 The practice of "attribution" by the Treasury is one way in which the impact of EC programmes is diminished by Government action. Attribution is the Treasury practice of attributing funds received from EC programmes to individual Government departments, whose budgets are then adjusted proportionately in the next public expenditure round. Evidence from the Treasury[6] indicated that in the case of EC R&D programmes the practice of attribution meant that only 30-35 pence in each pound were a genuine addition to resources. Attribution is contrary to the principle of "additionality", the Community doctrine that receipts from Community funds are in addition to national public expenditure, not in lieu of it.

8.8 **To sum up then, witnesses were generally of the view that EC programmes are worthwhile but that access to them is not easy and could be better assisted by Government.**

CHAPTER 9 THE OPINION OF THE COMMITTEE

The problem

9.1 The failure of British manufacturing industry to remain competitive has had serious consequences. Our manufacturing base has declined. Our home market is increasingly penetrated by imports. Our share of world markets in manufactured goods is too small. The implications for our future prosperity are grave.

9.2 The Government makes much of improvements in productivity and profitability in the 1980s. Of course these are important and welcome. But these improvements have been accompanied by a serious reduction in the manufacturing base. The small size of the remaining manufacturing base will constrain the growth in output which we will need in the future. Only a substantial increase in output can correct the huge deficit on our balance of trade, without a decline in the quality of life in the United Kingdom.

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[1] See for example PP. 11, 82, 88, 98, 108.
[2] See similarly p. 65; P. 72.
[3] See also PP. 94, 116.
[4] See also P. 139.
[5] See also PP. 11, 268.
[6] European Communities Committee, 17th Report (1989-90): *A Community Framework for R&D* (HL Paper 66), pp. 54-67.

9.3 The Government also makes much of the slight improvement in the deficit in recent years. But this has been largely the result of inward investment from abroad, which has shielded us from the full effects of our industrial decline. It has also been due to lower home demand because of high interest rates and other anti-inflationary measures. When the economy expands again and demand increases, the deficit will grow again unless industry becomes more competitive and so increases profitable sales.

9.4 The problems of our shrinking manufacturing base can no longer be ignored, particularly in view of the damage being done by the current recession. The Government must abandon its Panglossian attitude.[1] The Select Committee on Overseas Trade warned in 1985 that "the present situation undoubtedly contains the seeds of a major political and economic crisis in the foreseeable future".[2] They believed that a healthy manufacturing base was central to the manufacturing economy[3] and we think this is as true today as it was then. That Committee said that service industry was no substitute for manufacturing because many services are dependent on manufacturing and only 20 per cent of services were tradeable overseas. They said price and non-price competitiveness, the quantity and quality of investment and interest rate and exchange rate policies were all fundamental to recovery. We agree with this analysis. Action is needed now to stop the decline of manufacturing industry.

9.5 The only hope for recovering our position is more innovative manufacturing. The best of British manufacturing companies are among the best in the world. They know that their success depends on being ahead of their competitors, and that this means meeting the needs of customers more effectively. They constantly improve performance through innovation in every area from design to marketing. Innovation is a key factor which enables them to be competitive. It is a necessary, though not sufficient, condition for industrial success.

9.6 But too many companies are less good and their boards must take a full share of the responsibility. Many invest too little in new or improved products, plant and systems. They rely on doing what they have done in the past and fail to seize the new opportunities created by changing customer demands. As a result their competitiveness declines. We must therefore create a climate in which innovation can more readily flourish.

National attitudes

9.7 The most urgent need is for a change in our culture. Unless we revise radically some of the attitudes which permeate our society the factors which help to make industry competitive —of which innovation is a most important one—will continue to be neglected. Antipathy to manufacturing industry runs deep in our society. Industry is held in low esteem and so attracts too little of the country's talent and other resources. The conditioning which leads to a belief that making things is a second-class occupation does us all a disservice. Our competitors in Germany, Japan and elsewhere rightly regard manufacturing as a prestigious and worthwhile occupation. They have pride in their industrial achievements. Once and for all we must shed the national attitudes which deter us from a vigorous pursuit of economic growth and progress through increased sales of competitive manufactured goods.

9.8 A concerted campaign must be mounted to convert the country to the realisation that manufacturing industry is vital to our well-being as a trading nation. Initiatives so far have been inadequate and taken piecemeal. Their effects have been limited. Industry Year in 1986, for example, generated some worthwhile activities. But it did not go far enough. Much more needs to be done, and quickly.

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[1] "Everything is for the best in the best of all possible worlds" was the creed of Dr Pangloss in Voltaire's *Candide*.

[2] Select Committee on Overseas Trade, Report (1984-85) (HL 238-I) paragraph 125.

[3] The Committee said in the Summary of Conclusions and Recommendations: "Unless the climate is changed so that steps can be taken to enlarge the manufacturing base, combat import penetration and stimulate the export of manufactured goods, as oil revenues diminish the country will experience adverse effects which include: (i) a contraction of manufacturing to the point where the successful continuation of much of manufacturing activity is put at risk; (ii) an irreplaceable loss of GDP; (iii) an adverse balance of payments of such proportions that severely deflationary measures will be needed; (iv) lower tax revenue for public spending on welfare, defence and other areas; (v) higher unemployment, with little prospect of reducing it; and (vi) the economy stagnating and inflation rising, driven up by a falling exchange rate. Taken together, these constitute a grave threat to the standard of living and to the economic and political stability of the nation."

9.9 The campaign must be led by Government. The Prime Minister and all his Cabinet must give it their unequivocal and whole-hearted support. In the past manufacturing industry has suffered from a perceived neglect by Government and from Government's indifference to the decline of our manufacturing base. This must now change.

9.10 Government Ministers must be heard to proclaim the central position of manufacturing to our national prosperity. They should take pains to acquaint themselves more closely with the workings of industry and with its needs. DTI should be consulted as a matter of course on all areas of Government policy, so that the likely impact on industry is fully understood and taken into account in decision-making. The Minister of State for Industry should be charged with responsibility to ensure that this is done. He should have close links with a Treasury Minister with the same remit.

9.11 Industry's part in the campaign is no less important. First, competitive remuneration packages must be offered. Unless careers in industry are shown to be financially rewarding talented people will continue to disregard them and our process of industrial decline will continue.

9.12 Secondly, industry must make the best use of its manpower and provide stimulating and challenging work at all levels. In particular new recruits should undergo a well-structured period of initial training and be given opportunities to make use of their newly-acquired knowledge. Otherwise there will be a drain of talented people from industry to other sectors where this need seems to be better appreciated.

9.13 Thirdly, industry must continue, and indeed step up, its activities aimed at establishing closer links with schools. It must aim to promote a clearer understanding of what industry does and to arouse interest and enthusiasm for the exciting achievements of manufacturing.

9.14 Fourthly, industrialists must be prepared to cultivate a higher public profile. They must seize every opportunity to fly the flag of manufacturing. Many of those industrial managers, both very senior and middle-ranking, who spoke to us showed themselves to be dynamic, committed and inspiring. Yet the common perception of manufacturing is that it is dull, dirty and undemanding. They must challenge this perception at every turn.

9.15 School-teachers and careers advisers must ensure that they are well informed about manufacturing industry and that they present it as an important part of our society, worthy of the attention and efforts of every individual.

9.16 Many organisations, especially certain charitable trusts and the professional institutions, already provide opportunities for teachers and pupils alike to have closer contacts with industry. But they are hampered by limited funds and the scale of the operation is inadequate. We recommend that every organisation working effectively in this field should receive financial support from Government, on the basis of a pound for every pound raised from other sources and spent on school/industry links. This would enable existing schemes to reach more people and build on already-established networks.

9.17 We hope that the media will provide better and more frequent opportunities for industry to present itself, as well as taking more account of the role of industry in our national life when producing their own material. This would contribute to overcoming public ignorance of industry. The role models which children and young people encounter need not all be sportspeople and entertainers. There are few as yet, but the idea of a celebrity industrialist is not a contradiction in terms.

9.18 The financial community too should acknowledge the role of manufacturing industry. A higher proportion of investments should go into supporting manufacturing on a long-term basis. Without such investment industry will not thrive, and the City will pay the price of seeing our economic strength dwindle.

9.19 All these steps to alter national attitudes to manufacturing industry would create a much improved climate in which effective innovation could flourish and expand. This would improve the competitiveness of our industry. It would increase our output and our market share by meeting the growing demand from consumers for higher quality goods and better value for money. Innovation in itself cannot guarantee commercial success, but without it our economy will inevitably decline.

9.20 The next question at issue then is how to increase the level of innovation in manufacturing industry in the United Kingdom, with the objective of an increased volume of profitable sales. Obviously the prime responsibility rests with individual companies. Innovation is specific to a company's own business. It must be planned and implemented in an individual company. Successful commercial decisions can only be taken if they are market-driven. But Government, the financial community, the education system and the science base all influence the scale and success of innovation performed by industry. The recommendations which follow are therefore addressed to all these sectors, as well as industry.

Inward investment

9.21 Support for inward investment in the United Kingdom by foreign companies should continue since inward investment is a valuable way in which the manufacturing capability of the United Kingdom can be enhanced in the short term. The experience of the motor car industry and the television industry in recent years demonstrates the contribution that large-scale foreign investment can make relatively quickly. We would therefore welcome increased inward investment by foreign manufacturers. The Government should continue its actions to encourage it.

9.22 Inward investment will only fully benefit the United Kingdom in the longer term if it is accompanied by the research, design, and development inputs which go to make an innovative enterprise. It is not sufficient for foreign manufacturers to conduct their production or assembly operations in the United Kingdom while other stages of the process continue to be based in the country of origin.

9.23 Inward investment should not be regarded as a substitute for the fundamental changes in British industrial culture which are so necessary to ensure a real industrial renaissance. Nor should it be a substitute for other measures to increase innovative performance.

Learning from the best

9.24 As we have said, some British firms are already innovative and dynamic. If more companies would emulate them, our industrial performance would be much improved in the long term. Far-reaching changes will take time to effect, but this should not deter companies from taking action to improve their performance now.

9.25 A major responsibility of every company therefore must be to seek out and implement the best practice in innovation in all its aspects. Companies must be open to new ideas from any source. They should assess their own organisation in terms of the features common to innovative firms, and see how it measures up. They must familiarise themselves with the practices of the most successful, and adapt and apply them in their own businesses.

9.26 The counterpart to this is that companies which have significantly improved their business should be prepared to talk openly about their experience and allow others to benefit. This need not entail giving secrets to the competition, for every business is unique. Furthermore it is in every company's interest to see an overall improvement in the competitiveness of British manufacturing.

9.27 Learning from the best will involve a variety of actions and attitudes. First and foremost is the high priority attached to identifying and meeting the needs of the customer. Changing customer demands and expectations are the trigger for innovation. The customer must be paramount.

9.28 Adoption of the best practice will also mean cultivating a positive and enthusiastic attitude to innovation at all levels in the business, led by the Chairman and the board. It will include rewarding "product champions" appropriately and not looking for scapegoats for the inevitable failures associated with high-risk innovative activity. It will mean undertaking proper strategic planning for the improvement of products and processes, identifying opportunities to be seized or weaknesses to be rectified. On the other hand it will also mean being flexible enough to respond quickly and surely when circumstances dictate a change of course, including taking the difficult decision to abandon a development project which has been overtaken by events.

9.29 In adopting best practice companies will need to ensure that their organisation is of the most appropriate shape for the furthering of innovation. This will vary from one company to another, but it must encourage open and easy communication between levels inside the company and between disciplines. Indeed, the divisions between functions will often disappear altogether as different skills are brought together in project teams. We welcome the progress which many companies have already made in integrating product design and production engineering, and urge others to emulate this.

9.30 Learning from competitors is important. A thorough and detailed acquaintance with the competition enables a company to stay in the forefront, rather than being marginalised by unforeseen attacks from a rival. Innovation by a competitor should be recognised as an incentive to go one better.

9.31 Companies must also be prepared to work in partnership with their customers and suppliers. They must acknowledge that the mutual long-term benefit to be derived from involving suppliers in their processes of innovation and strategic planning far outweighs the apparent short-term benefit of dealing with suppliers on a least-cost basis.

9.32 A company must keep abreast of developments in its field, wherever they arise. Successful companies recognise that their own R&D staff do not have a monopoly of good ideas, but should also be employed in laying the foundations which enable the business to absorb and implement ideas from elsewhere, whether through licensing, technical agreements or personal contacts. Innovative companies devote resources to spotting potential winners, and when a promising avenue emerges they pursue it wholeheartedly regardless of its origin.

Dividend policies

9.33 In following the example of successful competitors companies should consider the respective proportions of profits which they devote to dividends and to investment, compared with companies in Japan and Germany. In those countries, companies place far greater emphasis on investment in innovation in order to increase market share. In the United Kingdom greater emphasis is placed on increasing the short-term yield on shareholders' funds.[1]

9.34 We recommend that British companies should pursue dividend policies more in line with those in Japan and Germany, taking care to explain them to their shareholders and financial institutions. This would facilitate increased investment in innovation from retained profits and so safeguard their future prospects. We greatly regret that City managers attach such importance to maintaining or even increasing dividends,[2] a policy which in times of recession can only be pursued at the expense of investment on R&D and innovation.

The relationship of industry to HEIs and Research Councils

9.35 The sources from which industry will derive the new knowledge which it applies in innovation include HEIs and Research Councils. We very much welcome therefore the closer relations between industry and the science base which have been forged in recent years. We also welcome the importance attached to such links by the Secretary of State (QQ 2239, 2335).

9.36 Attempts by Research Councils and HEIs to improve technology transfer and to promote commercial application of their knowledge have on the whole been successful and effective. Much of industry too has demonstrated its willingness to become more closely involved, though we regret that all too often foreign companies have been quicker to take advantage of new initiatives than have British companies. We urge industry in the United Kingdom to consider how adequately it uses the skill and expertise of HEIs and Research Councils, which are one of our greatest national resources.

9.37 Although links between industry and academia have improved substantially in recent years there is still much which could be done. These two communities have much to offer one another and greater interaction particularly in policy formation could only be of benefit.

9.38 Nowadays an increasing number of industrialists are involved in the governance of HEIs, and this has provided a welcome and valued input of different experience and skill. We recommend that more staff of HEIs should be similarly involved on the boards of companies, perhaps as non-executive directors. The interdependence of industry and HEIs is recognised in Germany and Italy, where industry welcomes the contribution made by scientists, engineers and others with a base in research and teaching. Their example could with advantage be followed in the United Kingdom. As well as enabling industry to benefit more from the resources of HEIs, the experience and understanding of industry which their staff would gain would improve general relations between the two communities.

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[1] This was one of the issues discussed at the conference "Short-termism and Innovation" organised by the DTI's Innovation Advisory Board in June 1990.

[2] The Chairman of M&G Group, for example, is reported as having written to companies in which the Group invests, urging them not to cut their dividend payments in the current recession. See *Financial Times*, 6 January 1991.

9.39 However, we urge that further improvements in the links between industry and HEIs should not be perceived by Government as an excuse for reducing support to HEIs and Research Councils. An over-emphasis of the commercial potential of their work could well be damaging to their role in meeting the country's long-term needs for basic research and for scientific and technological manpower. ABRC should monitor the situation to safeguard against any damaging over-emphasis on short-term gains and saving of Government expenditure.

Tax and accounting

9.40 One massive disadvantage which is faced by British industry is the high cost of capital in the United Kingdom compared to that in competitor countries. High interest rates, and the expectation by investors of high financial returns, can discourage industrial investment in innovation. In these circumstances it is important that wherever possible obstacles to investment should be reduced.

9.41 One way in which this should be done is by encouraging greater use of self-generated funds for innovation. One hundred and fifty per cent of expenditure on R&D should be exempt from corporation tax. We recommend that such an allowance should be based not on total expenditure but on the amount of real additional expenditure which a company makes over its previous year's total, in line with Japanese practice, with due allowance for the effect of company mergers. In this way the overall amount of R&D funded by industry would be raised, and companies would be encouraged to regard R&D less as a cost to be cut and more as a valuable investment to be enhanced. This would be of especial benefit in times of recession, when United Kingdom companies have traditionally cut R&D spending.

9.42 One hundred and fifty per cent allowances on R&D spending should only be available to those companies which declare such expenditure in line with SSAP 13.[1] We recommend that such declaration should be made a legal requirement.

9.43 We also urge Government to review the activities of local tax inspectors in view of the suggestion by Glaxo (see paragraph 5.35 above) that they are effectively disallowing tax relief on capital spent on development rather than research. We do not believe that this is the intended effect of current tax law. Given the very high costs of development and the high-risk nature of the activity it is very necessary that existing tax concessions in this area should be maintained in order to stimulate innovation. If necessary revised instructions should be issued to tax inspectors to clarify the situation.

9.44 Another way in which the tax regime should be altered to encourage more innovative investment by industry is by allowing individual companies to choose for themselves the rate of depreciation against tax for plant and machinery. In order to apply the necessary financial discipline, it should of course be the same rate as that shown in their published accounts. Companies could thus choose a rate to suit their business and get out of the arbitrary strait-jacket which currently constrains their liquidity and so their ability to invest.

9.45 Such a change would help to restore the cash resources of capital intensive businesses, by encouraging greater use of self-generated funds. It would allow amortization to reflect technological and not just mechanical obsolescence. It will encourage United Kingdom industry to increase levels of investment which in the 1980s have been too low, and will go some way to mitigate the damaging effects of high interest rates which, although necessary to control inflation, are in danger of eroding our already small manufacturing base still further. We are not convinced by the suggestion of the Inland Revenue that a return to free depreciation in this form would encourage poor quality investment. In the present economic climate no company can afford to another, but it must encourage open and easy communication between levels inside the company and between disciplines. Indeed, the divisions between functions will often disappear altogether as different skills are brought together in project teams. We welcome the progress which many companies have already made in integrating product design and production engineering, and urge others to emulate this.

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[1] SSAP is printed in full on pp. 33-37 of *Definitions of R&D*, 3rd Report of the Select Committee on Science and Technology 1989-90 (HL Paper 44).

9.30 Learning from competitors is important. A thorough and detailed acquaintance with the competition enables a company to stay in the forefront, rather than being marginalised by unforeseen attacks from a rival. Innovation by a competitor should be recognised as an incentive to go one better.

9.31 Companies must also be prepared to work in partnership with their customers and suppliers. They must acknowledge that the mutual long-term benefit to be derived from involving suppliers in their processes of innovation and strategic planning far outweighs the apparent short-term benefit of dealing with suppliers on a least-cost basis.

9.32 A company must keep abreast of developments in its field, wherever they arise. Successful companies recognise that their own R&D staff do not have a monopoly of good ideas, but should also be employed in laying the foundations which enable the business to absorb and implement ideas from elsewhere, whether through licensing, technical agreements or personal contacts. Innovative companies devote resources to spotting potential winners, and when a promising avenue emerges they pursue it wholeheartedly regardless of its origin.

Dividend policies

9.33 In following the example of successful competitors companies should consider the respective proportions of profits which they devote to dividends and to investment, compared with companies in Japan and Germany. In those countries, companies place far greater emphasis on investment in innovation in order to increase market share. In the United Kingdom greater emphasis is placed on increasing the short-term yield on shareholders' funds.[1]

9.34 We recommend that British companies should pursue dividend policies more in line with those in Japan and Germany, taking care to explain them to their shareholders and financial institutions. This would facilitate increased investment in innovation from retained profits and so safeguard their future prospects. We greatly regret that City managers attach such importance to maintaining or even increasing dividends,[2] a policy which in times of recession can only be pursued at the expense of investment on R&D and innovation.

The relationship of industry to HEIs and Research Councils

9.35 The sources from which industry will derive the new knowledge which it applies in innovation include HEIs and Research Councils. We very much welcome therefore the closer relations between industry and the science base which have been forged in recent years. We also welcome the importance attached to such links by the Secretary of State (QQ 2239, 2335).

9.36 Attempts by Research Councils and HEIs to improve technology transfer and to promote commercial application of their knowledge have on the whole been successful and effective. Much of industry too has demonstrated its willingness to become more closely involved, though we regret that all too often foreign companies have been quicker to take advantage of new initiatives than have British companies. We urge industry in the United Kingdom to consider how adequately it uses the skill and expertise of HEIs and Research Councils, which are one of our greatest national resources.

9.37 Although links between industry and academia have improved substantially in recent years there is still much which could be done. These two communities have much to offer one another and greater interaction particularly in policy formation could only be of benefit.

9.38 Nowadays an increasing number of industrialists are involved in the governance of HEIs, and this has provided a welcome and valued input of different experience and skill. We recommend that more staff of HEIs should be similarly involved on the boards of companies, perhaps as non-executive directors. The interdependence of industry and HEIs is recognised in Germany and Italy, where industry welcomes the contribution made by scientists, engineers and others with a base in research and teaching. Their example could with advantage be followed in the United Kingdom. As well as enabling industry to benefit more from the resources of HEIs, the experience and understanding of industry which their staff would gain would improve general relations between the two communities.

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[1] This was one of the issues discussed at the conference "Short-termism and Innovation" organised by the DTI's Innovation Advisory Board in June 1990.

[2] The Chairman of M&G Group, for example, is reported as having written to companies in which the Group invests, urging them not to cut their dividend payments in the current recession. See *Financial Times*, 6 January 1991.

9.39 However, we urge that further improvements in the links between industry and HEIs should not be perceived by Government as an excuse for reducing support to HEIs and Research Councils. An over-emphasis of the commercial potential of their work could well be damaging to their role in meeting the country's long-term needs for basic research and for scientific and technological manpower. ABRC should monitor the situation to safeguard against any damaging over-emphasis on short-term gains and saving of Government expenditure.

Tax and accounting

9.40 One massive disadvantage which is faced by British industry is the high cost of capital in the United Kingdom compared to that in competitor countries. High interest rates, and the expectation by investors of high financial returns, can discourage industrial investment in innovation. In these circumstances it is important that wherever possible obstacles to investment should be reduced.

9.41 One way in which this should be done is by encouraging greater use of self-generated funds for innovation. One hundred and fifty per cent of expenditure on R&D should be exempt from corporation tax. We recommend that such an allowance should be based not on total expenditure but on the amount of real additional expenditure which a company makes over its previous year's total, in line with Japanese practice, with due allowance for the effect of company mergers. In this way the overall amount of R&D funded by industry would be raised, and companies would be encouraged to regard R&D less as a cost to be cut and more as a valuable investment to be enhanced. This would be of especial benefit in times of recession, when United Kingdom companies have traditionally cut R&D spending.

9.42 One hundred and fifty per cent allowances on R&D spending should only be available to those companies which declare such expenditure in line with SSAP 13.[1] We recommend that such declaration should be made a legal requirement.

9.43 We also urge Government to review the activities of local tax inspectors in view of the suggestion by Glaxo (see paragraph 5.35 above) that they are effectively disallowing tax relief on capital spent on development rather than research. We do not believe that this is the intended effect of current tax law. Given the very high costs of development and the high-risk nature of the activity it is very necessary that existing tax concessions in this area should be maintained in order to stimulate innovation. If necessary revised instructions should be issued to tax inspectors to clarify the situation.

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9.45 Such a change would help to restore the cash resources of capital intensive businesses, by encouraging greater use of self-generated funds. It would allow amortization to reflect technological and not just mechanical obsolescence. It will encourage United Kingdom industry to increase levels of investment which in the 1980s have been too low, and will go some way to mitigate the damaging effects of high interest rates which, although necessary to control inflation, are in danger of eroding our already small manufacturing base still further. We are not convinced by the suggestion of the Inland Revenue that a return to free depreciation in this form would encourage poor quality investment. In the present economic climate no company can afford to invest money frivolously and we are in no doubt that this change would be of benefit. Nor do we accept that such a change should be accompanied by a return to a higher rate of corporation tax. The pressing need to revive the fortunes of industry requires additional incentives to investment, to ensure that the exploitation stage of the innovation process is not neglected.

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[1] SSAP is printed in full on pp. 33-37 of *Definitions of R&D*, 3rd Report of the Select Committee on Science and Technology 1989-90 (HL Paper 44).

MANPOWER AND SKILLS

9.46 The shortage of skilled manpower is a matter of the utmost concern. Without the necessary talent and training in the workforce innovation, and therefore industry, will never thrive. There is also a need for a higher level of scientific and technological education in society generally, not just in the workforce. A better educated population would provide industry with more demanding consumers and the expectation of higher quality in the home market, which would encourage greater competitiveness in world markets.

9.47 We have not however considered these important issues in detail since ACOST is currently carrying out a study of the area. Regrettably their report has not been available to us during our enquiry. But we hope that it will be completed soon and its publication approved.

9.48 We hope that the National Curriculum will help to improve general educational standards. Such improvement is a necessary condition for successful innovation. We urge the Government to devote adequate resources to implementing it, particularly through training of both existing and new teachers.

9.49 Although some companies take training seriously, too many do not. Those which do are often therefore providing skilled personnel for other companies. To encourage more companies to use their own funds to invest in training, and to acknowledge the contribution of those which add to the national pool of expertise, more than 100 per cent of company expenditure on training should be exempt from taxation. There must of course be safeguards, that the training so provided meets minimum standards and provides skills for which there is a real demand. But such a change will encourage industry to regard training as an investment rather than a cost. A new Accounting Standard may be necessary.

9.50 Continuing education and training throughout the working life has become increasingly important with rapidly changing technology. The Engineering Council has highlighted this. We consider it appropriate that in future individuals should benefit from the same tax treatment of training costs that industry currently enjoys. We recommend that the costs of such approved courses of training paid for by the individual should be an allowable deduction from personal income for tax purposes. In the case of those engaging in full-time training, the benefit should be carried forward to the next period in which they are liable for income tax. This would encourage individuals to undertake training on their own initiative and so maintain and update their skills. It would promote a more positive approach to training and demonstrate Government's commitment to creating a highly qualified and skilled workforce.

9.51 We welcome the recent initiatives of some HEIs in introducing postgraduate courses in innovation management. The skills and experience of industrial managers are crucial to successful innovation and an understanding of the process of managing technology will be an even greater asset in the future. However the scale of such initiatives is small and they are little known. Government should ensure that they are adequately funded and able to expand as demand increases.

9.52 It is imperative for business schools and other HEIs providing management training to review the place of technology and innovation in their courses. Some HEIs ensure that the importance of technological innovation to an industrial enterprise is reflected in the courses which they offer, and we commend them for it. But we regret that others do not. While not every manager can be an engineer or scientist, it is essential that every manager should be alive to the opportunities and difficulties which innovation presents. Such training should be a feature of all business school courses.

9.53 We welcome the increasingly close collaboration between some companies and HEIs to ensure the relevance of education to industry's needs, and the work of the Engineering Council and the professional institutions in this respect. Education has many other important objectives but one of its aims must be to develop individuals able to contribute to our national economic success. Proper interaction between industry and the educational community will help to ensure that this is achieved.

"SHORT-TERMISM" AND TAKEOVERS

9.54 We consider "short-termism" to be a real problem. Over-emphasis, for whatever reason, on this year's achievements rather than the long-term prospects of a business is damaging to industry. Given that the problem is attitudinal, it should not be surprising that its existence cannot be proved statistically. Moreover, the fact that most managers in industry perceive there to be a problem is in itself likely to do damage.

9.55 There can be no virtue in attempting to apportion blame for the problem. But it seems to be rooted deep in our business culture which favours deal-driven activity, automatic expectations of high returns on investment and the dominance of financial professionals over scientists, technologists and engineers: These are difficulties which do not beset our European and Japanese competitors, though they are equally apparent in the USA. Any attempt to overcome "short-termism" will have to tackle these cultural roots, and here we reiterate our theme of promoting a greater esteem for wealth creation through manufacturing. We also propose a number of actions which would help alleviate the problem by bringing the industrial and financial communities closer together and increasing their confidence in one another.

9.56 First, companies must put their own house in order and ensure that nothing in their own organisation encourages short-termism. They should review their systems of incentives to managers to ensure that they do not favour an emphasis on current year's results. They should consider introducing instead incentives which depend on performance over a longer period, of perhaps five years, and greater use of stock options which are exercised on a long-term basis.

9.57 Company employees who are pension fund trustees should also review the demands that they make on their fund managers. They should, for example, consider setting longer periods for performance review and favour fund managers who act in ways which they think preferable for the well-being of industry. The duty of a pension fund trustee, or of a fund manager, is of course to the fund's pensioners. But this entails not only the short-term interests of those currently drawing pensions but also the long-term interests of those still contributing to the fund. The latter will not be best served by a policy which concentrates only on short-term growth. Companies and fund managers together should ensure that trustees are properly briefed and that they understand their responsibilities.

9.58 Companies must all follow the example of the best in carrying on a constructive dialogue with their shareholders about their innovation plans. They should take care to explain the risks as well as the potential rewards and to be frank about costs and time-scales. They should set out in annual reports their plans for all types of investment—machinery and plant, R&D, training—and the expected benefits, and draw attention to the specific returns which have arisen from such investment in the past. Such dialogue would enable shareholders and analysts to make more informed decisions about a company's prospects and would encourage long- rather than short-term expectations and commitments. The willingness of the City to take a long-term view in certain circumstances is demonstrated by its patient investment in Japan, where current yields are often modest.

9.59 Not only companies have a responsibility to solve the problem of short-termism. It is just as important that the financial community plays its part. One way in which it can do this is by increasing its ability to understand the workings of industry. Institutional shareholders and brokers should adopt a policy of recruiting a higher proportion of their analytical staff with scientific or technological qualifications and with experience of industry. They could then play a more active, informed role in the dialogue about a company's performance and about the financial support necessary for sustained innovation.

9.60 The proliferation of takeovers in the United Kingdom in the 1980s was a significant factor in creating short-term attitudes. With industrial managers having to look over their shoulders for predators it is not surprising that they should sometimes appear preoccupied with the share price and the next quarter's profits rather than the sustained good performance of the company which investment in innovation can help to achieve.

9.61 We recognise that there are many cases in which agreed mergers are beneficial for the efficient management of industry. Undoubtedly measures to discourage contested bids would on occasion discourage acquisitions which might be desirable. However, we consider that the damage done to manufacturing industry generally by the "deal culture" is sufficient to warrant action.

9.62 We therefore welcome the valuable attempts of the Innovation Advisory Board to air the problems which can be created by the apparent threat of takeover and to propose solutions.[1]

9.63. We go further however in recommending that voting rights should be enjoyed only by those shareholders who have held their shares for at least a year. This should ensure that only those shareholders who have demonstrated a measure of long-term commitment to a company would be able to influence its future policy and ownership. It should reduce the incidence and threat of takeover without significantly affecting the marketability of a company's shares and so the price it must pay to raise equity. We recommend that companies legislation should be amended to this effect.

9.64 We do not consider that the constant threat of takeover is needed as a spur to efficient management of a company, nor that the removal of that threat will result in slackness. Constant fear of takeover, even if unfounded, hardly provides a background against which sensible business decisions can be made, especially those relating to long-term issues such as innovation.

9.65 One way of maintaining oversight of management, to reassure shareholders that effectiveness is not lessened by the reduced threat of contested takeover, is to strengthen the influence of active, well-qualified, independent non-executive directors. This would also provide valuable stability and support to company management particularly on long-term issues such as investment for innovation.

9.66 Furthermore principal shareholders should in future play a more active role in the appointment of non-executives. It is not sufficient for shareholders to rely entirely on nominations from the board, which they virtually "rubber stamp" at a later date.

GOVERNMENT SUPPORT OF INNOVATION

9.67 In addition to giving a lead in a campaign to raise the profile of manufacturing industry, Government can undertake a number of specific actions to promote innovation.

9.68 One of the prime ways in which Government could demonstrate a commitment to innovation would be to devote a higher proportion of public funds to innovation in manufacturing industry. Public expenditure on R&D in the United Kingdom is not growing in line with that in competitor countries. Moreover a much greater proportion of that expenditure is devoted to defence.[2] Unlike in the USA, where "spin-off" from defence to civil industry is substantial and well-organised, civil sector industry in the United Kingdom benefits scarcely at all from this expenditure, and is disadvantaged as a result.

9.69 Industry's own expenditure on R&D has grown in recent years as industry has sought to make up for the withdrawal by Government from funding of research close to the market. This increased commitment should be matched by Government, not regarded as an opportunity for cutting back on public expenditure. Failure by Government to maintain the national R&D budget gives the wrong signals to industry about the importance of R&D and the innovation process to the national economy.

9.70 Another way in which Government could demonstrate belief in the importance of innovation would be to restore the DTI budget for industrial innovation to the real levels of the mid-1980s. In the money of the day this peaked at £283 million in 1985-86 and has since declined to £121 million (planned) in 1990-91 (see Appendix 4, Table 2A and Figure 8). This trend should be reversed. The increased budget should be spent as advised by active industrialists. In seeking the most appropriate forum for such advice to be given, the DTI should consider the pattern of the former Research Requirements Boards, and the example of procedures in competitor countries with a good innovative record.

9.71 We fully recognise that waste can result from indiscriminate Government support for industry, which can encourage bad commercial decisions and subsidise inefficiency. But we believe that properly targeted, selective Government support for innovation can be of great value. The pharmaceutical and aerospace sectors are examples which demonstrate this. In both cases Government support has enabled the maintenance of healthy and competitive industries, with good market share and a positive balance of trade. Far from encouraging inefficiency, Government support has achieved good value for money. The objective must be to find the optimum level of Government assistance to other industries. We believe the present level of Government support for innovation is below the optimum.

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[1] *Promoting Innovation and Long-Termism*, Innovation Advisory Board, October 1990.

[2] For a discussion of this point see Science and Technology Committee, 3rd Report Session 1989-90: *Definitions of R&D* (HL Paper 44).

Wider Government policies

9.72 Government's handling of the economy should be conceived with the needs of industry in mind. High interest rates in particular are damaging to industry since a company requires a higher rate of return to justify investment in innovation compared with overseas competitors. Investment is deterred and the company's performance falls behind. While we recognise the role which high interest rates play in controlling inflation, we fear their consequences for Britain's industrial future. The Government should explore once again the possibility of preferential interest rates for innovation in industry. We recognise the difficulty which the Secretary of State identified (Q 2286) in ensuring that such funds are used for the purpose intended, but we consider that the potential lasting damage to industry of a prolonged period of high interest rates and therefore reduced investment is grave enough to warrant a serious attempt to implement a workable scheme. It would reinforce the benefits to be gained by our earlier recommendations to encourage the re-investment by companies of self-generated funds (see paras 9.33, 9.44 and 9.45 above).

9.73 Another problem which industry faces is that Government no longer has any view of the strategic importance to the nation of certain industries, or indeed of industry as a whole. If market forces alone are to determine the course of events it is conceivable that we will end up with no significant British-owned manufacturing industry in the United Kingdom. Government has a legitimate role in identifying and promoting generic technologies and industrial sectors of key importance for the future. We are not suggesting that the Government should "pick winners" but that they should take a strategic view of those areas in which we could or should have competitive advantage in the 1990s and beyond. We recommend that ACOST, with strengthened industrial membership, should be invited to advise the Prime Minister on this, and that that advice should whenever possible be made public.

DTI action

9.74 If, as we think right, DTI is to play a more active role in support of industry, the Department must be strengthened. In recent years the frequent changes of Secretary of State have lessened the political influence of the Department and given rise to significant discontinuities. Moreover, the amalgamation of the trade and industry portfolios has reduced the attention given to industrial matters. We recommend that Government should so far as possible maintain continuity in the political leadership of the Department. The Department would also be strengthened by recruiting a higher proportion of staff, on secondment from industry, with first-hand experience of managing technological innovation.

9.75 Generally industry is best placed to assess its markets and make decisions about investment in innovation. But, as DTI has said (p. 38), industry alone may not always generate sufficient innovation for the national good. Moreover competitor governments provide systematic and wide-ranging support for innovation in their industry. In particular, Government support is appropriate for SMEs which frequently have inadequate resources to invest in innovation.

9.76 We therefore welcome the introduction of SPUR, which will provide grants to individual SMEs for product and process development. SMEs have often been deterred from participation in existing schemes by the requirement that they collaborate with another company, which is difficult for an enterprise with few resources. We await with interest an announcement of the detailed workings of SPUR and of the other new schemes for technical assistance to SMEs. We urge that they should be adequately funded.

9.77 We also welcome the recent changes in the LINK scheme to allow projects involving only one company and one HEI. This change should make it easier for SMEs in particular to participate, We hope too that it will encourage greater take-up of LINK funds which as yet have had little impact.

9.78 The second area in which enhanced Government support could be particularly beneficial is that of projects too costly and risky for industry alone, but where it is desirable for the United

Kingdom to maintain a strategic capability in key sectors. Launch aid, which has been so successful in aerospace, should be extended to support high-risk, large-scale product developments in other sectors.

9.79 Other governments devote considerable effort to the development and delivery of innovation support mechanisms at regional level. The activities of the DTI in the regions are, by contrast, almost negligible. We recommend that the regional technology centres should be strengthened.

9.80 The Scottish Development Agency has an admirable record in generating substantial innovative industrial development in Scotland. The Welsh Development Agency has done the same in Wales. However there is nothing of the kind for parts of England where the need is just as great. We recommend that the activities of the Development Agencies should be taken as a model for exploiting more effectively the technological and industrial potential of other areas of the United Kingdom, building on local loyalties and existing organisations. They should emulate the example of the *Länder* in Germany, which take a strategic view of technological and industrial development and support a broad range of activities which encourage innovative manufacturing industry.

9.81 DTI schemes must be more stable and consistent if industry is to benefit from them. It takes time to become acquainted with the way in which a scheme operates, to check compliance with the qualifying requirements and to prepare an application. If the schemes change with the frequency with which they have in the past, then companies can be overtaken by events. Schemes should only be altered to meet changing needs, or if they are shown to be ineffective. They should not be altered simply for the sake of gaining political kudos from a “new initiative”.

9.82 Schemes must also be more readily accessible and easily understood, as the expense and time involved in applications can be an obstacle. They must be administered with the minimum of bureaucracy compatible with proper selectivity and targeting.

9.83 DTI should do more to identify and disseminate best practice, based on United Kingdom as well as foreign examples. Most companies could benefit greatly from learning from the more successful, and DTI could assist this process.

9.84 DTI schemes such as SMART and the Enterprise Initiative are worthwhile but are too small-scale to have appreciable impact. They should be expanded. SMART for example should not be subject to cash limits. Its scale should be limited by the number of high quality applications rather than by financial constraints. We welcome the use made of existing local networks for dissemination of information about such schemes and recommend that it should be expanded.

9.85 DTI’s encouragement of collaborative research at present emphasises horizontal collaboration. But vertical collaboration (that is between suppliers and customers) is an equally effective way of promoting innovation. It can assist relations between companies of different sizes, whereas horizontal collaboration is more likely to take place between organisations of similar size. Companies which are already working in this way show the advantages. We therefore recommend that effective collaboration in either direction should be eligible for DTI support.

9.86 Other governments provide greater assistance to companies, in locating and tapping technological information from overseas. The DTI should expand its overseas technological information retrieval system on the lines of the Japanese model, especially to help SMEs for whom the function is vital but inhibitingly costly.

THE EUROPEAN COMMUNITY

9.87 The value of collaborative research in manufacturing industry funded through EC programmes is significant, in spite of various obstacles identified by witnesses. With the objective of making better use of EC funding particularly amongst smaller firms, we recommend that Government should take all practical steps to achieve a reduction in the bureaucracy and complications involved in these programmes.

9.88 We also urge Government to improve communications with industry so that the availability of EC support for collaborative research is more widely known and application procedures better understood.

CONCLUSION

9.89 Our recommendations will necessarily result in more Government interest and involvement in industry. While the mistakes of the past have caused these ideas to become unfashionable, the pendulum has swung too far the other way. All the evidence shows that the present lack of Government commitment, support and assistance is deeply damaging to industry and to our national interest. We are confident that the changes we recommend would contribute significantly to restoring a better balance between the two extremes of Government policy. This would enable industry to meet the challenges of the 1990s and promote a stable, prosperous economy.

9.90 We also recognise that the implementation of some of our recommendations will involve additional Government expenditure or loss of tax revenue in the short term. But we firmly believe the action proposed is an essential part of an overall package to reverse the decline in our manufacturing base and improve our balance of overseas trade. In our view this is necessary to ensure a prosperous economy. The expenditure involved should be regarded as a sound investment by Government in the future prosperity of the United Kingdom on behalf of us all and not as a cost to be reduced to a minimum.

CHAPTER 10 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

10.1 Industry's failure to remain competitive has grave implications for our future prosperity (para 9.1).

10.2 While productivity and profitability have improved, only a substantial increase in output can correct the huge deficit on our balance of trade (para 9.2).

10.3 Action is needed now to stop the decline of our manufacturing industry (para 9.3).

10.4 Innovation is a necessary, though not sufficient, condition for industrial success (para 9.5).

10.5 The best British manufacturing companies are among the best in the world (para 9.5).

10.6 Too many companies however are insufficiently innovative or competitive. We must create a climate in which innovation can more readily flourish (para 9.6).

10.7 We must change the national attitudes which lead to the belief that manufacturing is a second class occupation (para 9.7).

10.8 We must have a concerted campaign to promote greater esteem for manufacturing (para 9.8).

10.9 Government must lead this campaign and proclaim the central position of manufacturing to our national prosperity. DTI should be consulted on other areas of Government policy so that the likely impact on industry is fully understood and taken into account (paras 9.9, 9.10).

10.10 Industry must offer competitive remuneration, to attract talented personnel (para 9.11).

10.11 Industry must make proper use of its manpower and provide stimulating and challenging work particularly for new recruits (para 9.12).

10.12 Industry must establish closer links with schools, building on existing relationships (para 9.13).

10.13 Industrialists must cultivate a higher public profile (para 9.14).

10.14 Government should fund on a pound for pound basis those non-profit making organisations working effectively to promote school/industry links (para 9.16).

10.15 We hope the media will help in projecting a more positive image of industry (para 9.17).

10.16 The financial community should acknowledge the importance of manufacturing industry (para 9.18).

10.17 Government should continue its actions to encourage inward investment, which will enhance manufacturing capability in the short term. Such investment must be accompanied by the research, design and development inputs which go to make an innovative enterprise (paras 9.21 to 9.23).

10.18 Companies must seek out and implement the best practice in innovation. This will involve:

(a) Attaching high priority to identifying and meeting the needs of the customer.

(b) Cultivating a positive and enthusiastic attitude to innovation, led by the Chairman/Chief Executive and the Board.

(c) Adopting a structure which encourages open and easy communications between company levels and between disciplines.

(d) Learning from the activities of competitors.

(e) Working in partnership with customers and suppliers.

(f) Being open to innovative developments and technologies from any source (paras 9.24 to 9.32).

10.19 Companies should pursue dividend policies which facilitate increased investment in innovation from retained profits. We regret that City managers emphasise the importance of dividends even at the expense of other priorities (paras 9.33, 9.34).

10.20 We welcome the closer relations between industry and the science base which have been forged in recent years (para 9.35).

10.21 We regret that British companies are often slow to take advantage of improved technology transfer from Research Councils and HEIs and urge them to improve their responsiveness (para 9.36).

10.22 Greater interaction in policy formation between industry and academia would be advantageous. More staff of HEIs should be involved on the boards of companies (para 9.38).

10.23 Further improvements in the links between industry and academia should not be perceived by Government as an excuse for reducing support to HEIs and Research Councils. ABRC should monitor this situation (para 9.39).

10.24 The high cost of capital is a massive disadvantage faced by British industry. Wherever possible obstacles to investment should be reduced (para 9.40).

10.25 One hundred and fifty per cent of industrial expenditure on R&D should be exempt from taxation, based on the amount of real additional expenditure which a company makes over its previous year's total (para 9.41). Such allowances should only be available to companies which declare their expenditure in line with SSAP 13, which should be made a legal requirement (para 9.42).

10.26 Government should review the activities of local tax inspectors in their interpretation of the law relating to tax relief on capital spent on development (para 9.43).

10.27 Companies should be allowed to choose for themselves the rate of depreciation against tax for plant and machinery. It should be the same rate as that shown in their published accounts. This change should not be accompanied by a return to a higher rate of corporation tax (paras 9.44, 9.45).

10.28 The shortage of skilled manpower is a matter of the utmost concern. We hope that the ACOST study of this subject will be completed soon and its publication approved (paras 9.46, 9.47).

10.29 The Government must devote adequate resources to implementing the new National Curriculum, particularly through training of both existing and new teachers (para 9.48).

10.30 More than 100 per cent of company expenditure on approved training should be exempt from taxation (para 9.49).

10.31 The costs of approved courses of training paid for by an individual should be an allowable deduction from personal income for tax purposes (para 9.50).

10.32 We welcome the introduction of postgraduate courses in innovation management. Government should ensure that they are adequately funded (para 9.51).

10.33 Business schools and other HEIs providing management training should ensure that the importance of technological innovation to an industrial enterprise is fully reflected in the courses which they offer (para 9.52).

10.34 We welcome the increasingly close collaboration between some companies and HEIs to ensure the relevance of education to industry's needs (para 9.53).

10.35 Short-termism is a real problem deeply rooted in our business culture. The favouring of deal-driven activity, automatic expectations of high returns on investment and the dominance of financial professionals over scientists, technologists and engineers all contribute (paras 9.54, 9.55).

10.36 Companies must ensure that their systems of incentives do not favour emphasis on current year's results (para 9.56).

10.37 Company managers who are pension fund trustees should review the demands that they make on their fund managers (para 9.57).

10.38 Companies must all follow the example of the best in carrying on a constructive dialogue with their shareholders about their innovation plans (para 9.58).

10.39 Institutional shareholders and brokers should adopt a policy of recruiting a higher proportion of their analytical staff with scientific or technological qualifications and with experience of industry (para 9.59).

10.40 The high incidence of takeovers is damaging to manufacturing industry and warrants action, even though there are cases when merger is beneficial (paras 9.60, 9.61).

10.41 We welcome the work of the Innovation Advisory Board (para 9.62).

10.42 Voting rights should be enjoyed only by shareholders who have held their shares for at least a year. Companies legislation should be amended to that effect (para 9.63).

10.43 The threat of takeover is not necessary as a spur to efficient management of a company (para 9.64).

10.44 The influence of active, well-qualified, independent non-executive directors should be strengthened. Principal shareholders should play a more active role in the appointment of non-executives (paras 9.65, 9.66).

10.45 Government should devote a higher proportion of public funds to innovation in manufacturing industry. Failure to maintain the national R&D budget gives the wrong signals to industry about the importance of R&D and the innovation process to the national economy (paras 9.68, 9.69).

10.46 The DTI budget for industrial innovation should be restored to the levels of the mid-1980s and active industrialists should advise on its disbursement (para 9.70).

10.47 Properly targeted selective Government support for innovation can be of great value. The present level of support is below the optimum (para 9.71).

10.48 The Government should explore again the possibility of preferential interest rates for innovation in industry (para 9.72)

10.49 Government has a legitimate role in identifying and promoting generic technologies and industrial sectors of key importance for the future. ACOST should be invited to advise the Prime Minister on this and that advice should whenever possible be made public (para 9.73).

10.50 The frequency of changes in the Secretary of State for Trade and Industry should be reduced, and the Department should be strengthened by recruiting, on secondment from industry, staff with first-hand experience of managing technological innovation (para 9.74).

10.51 Government support is particularly appropriate for SMEs. We welcome the introduction of new schemes to assist them and urge that they should be adequately funded (paras 9.75, 9.76).

10.52 We welcome recent changes in the LINK scheme and hope they will encourage greater take-up of funds (para 9.77).

10.53 Launch aid should be extended to support high risk large scale product developments in sectors other than aerospace (para 9.78).

10.54 The regional technology centres should be strengthened. The activities of the Scottish and Welsh Development Agencies should be taken as a model for exploiting more effectively the technological and industrial potential of other areas of the UK (paras 9.79, 9.80).

10.55 DTI schemes should only be altered to meet changing needs or if they are shown to be ineffective. They should not be altered simply for the sake of gaining political kudos from a "new initiative" (para 9.81).

10.56 DTI schemes must be made more readily accessible and easily understood (para 9.82).

10.57 DTI should assist the process of dissemination of best practice on innovation (para 9.83).

10.58 SMART and the Enterprise Initiative should be expanded. SMART should not be subject to cash limits (para 9.84).

10.59 DTI should do more to promote vertical collaboration (that is between suppliers and customers) as a way of encouraging innovation (para 9.85).

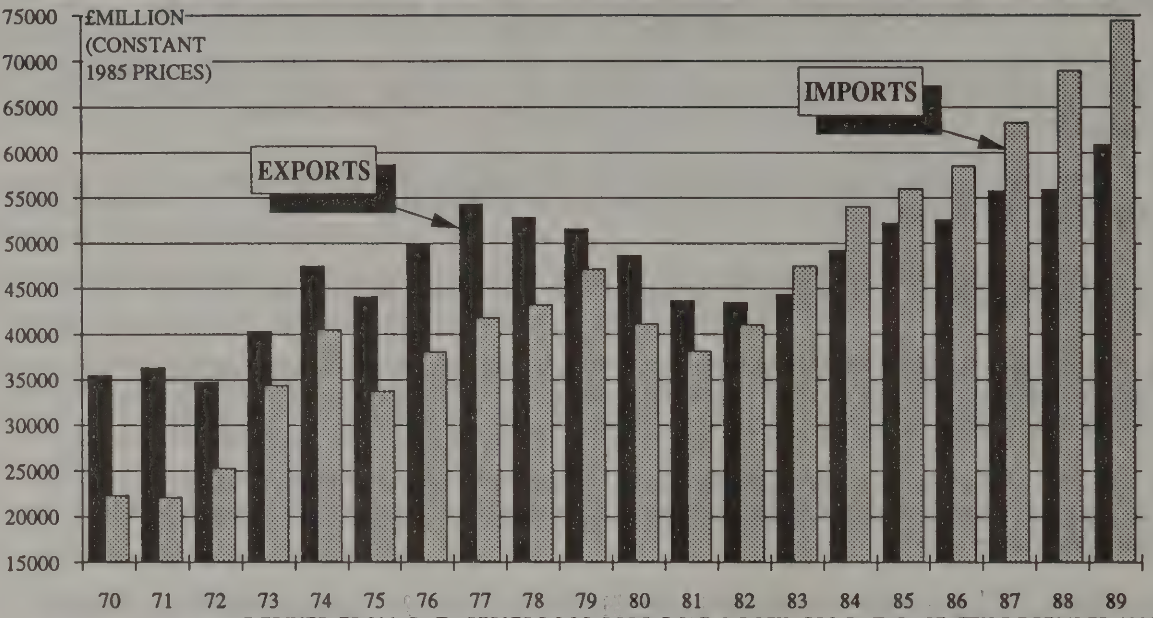
10.60 The DTI should expand its overseas technological information retrieval system (para 9.86).

10.61 Government should work to reduce the complications involved in EC programmes, and assist in making them known to and understood by British companies (paras 9.87, 9.88).

10.62 The present lack of Government commitment, support and assistance to industry are damaging to our national interest (para 9.89).

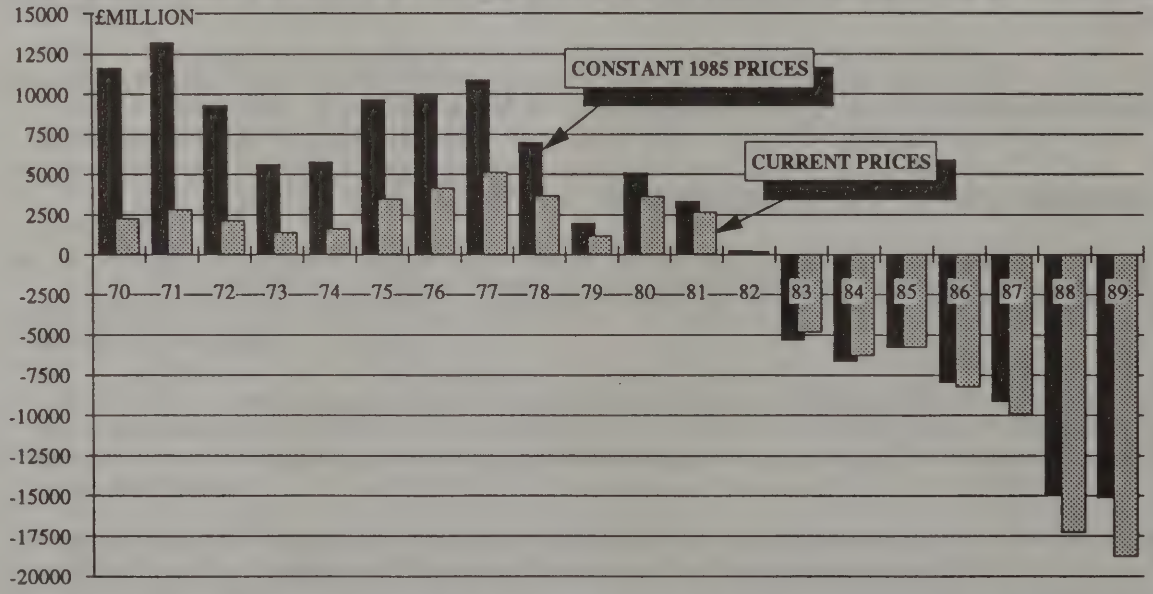
10.63 Expenditure by Government on support of industry should be regarded as an investment on behalf of us all, not a cost to be cut (para 9.90).

FIG. 1: UK EXPORTS AND IMPORTS OF MANUFACTURES (1970 - 1989)



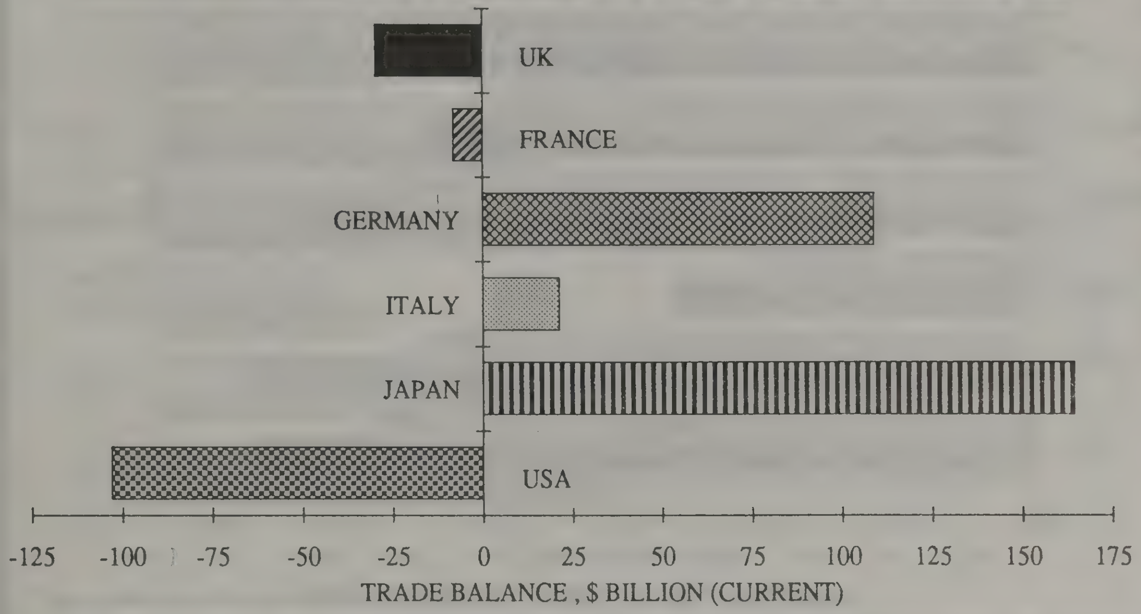
DERIVED FROM: DATA SERIES BOQS, BPBS, DJAF & DJCX, CSO DATABASE, 7TH DECEMBER 1990.

FIG. 2: UK BALANCE OF TRADE IN MANUFACTURED GOODS (1970 - 1989)



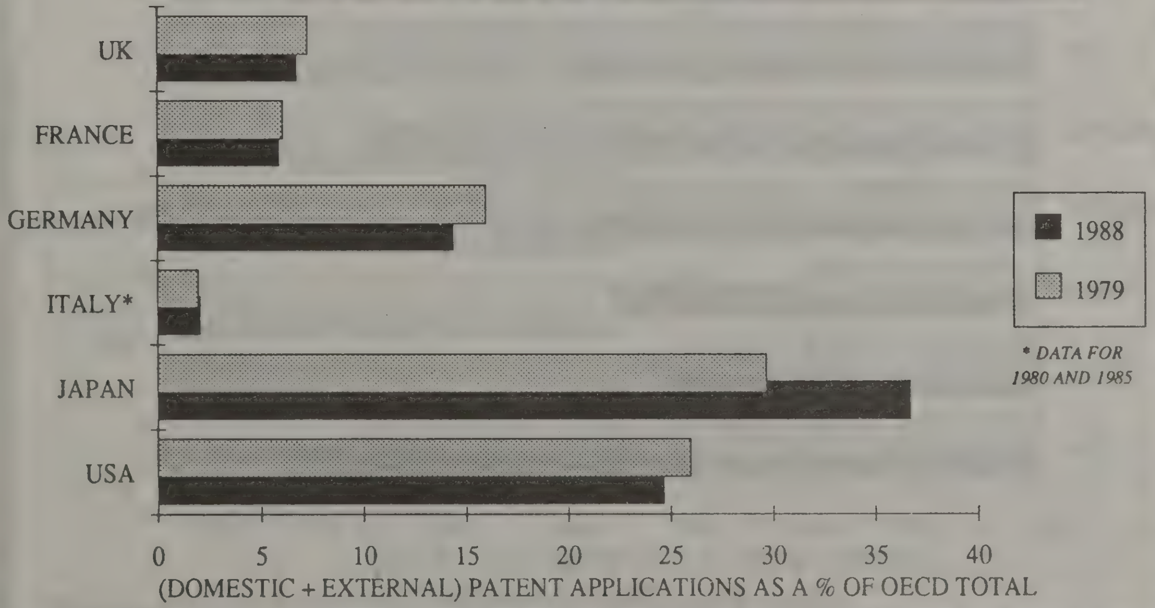
DERIVED FROM: DATA SERIES BQAE, DJAF & DJCX, CSO DATABASE, 7TH DECEMBER 1990.

FIG. 3: BALANCE OF TRADE IN MANUFACTURED GOODS (1989)



DERIVED FROM: 'INDUSTRIAL POLICY IN OECD COUNTRIES - ANNUAL REVIEW', OECD, PARIS, 1990, Table 2.

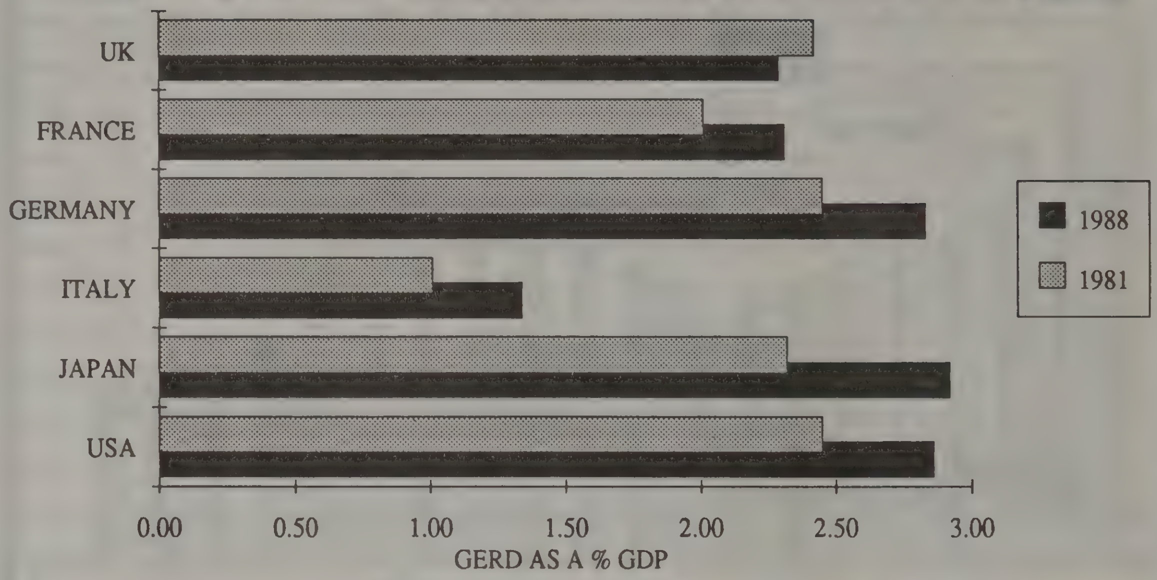
FIG. 4: NATIONAL SHARES OF OECD PATENT APPLICATIONS



** DATA FOR 1980 AND 1985*

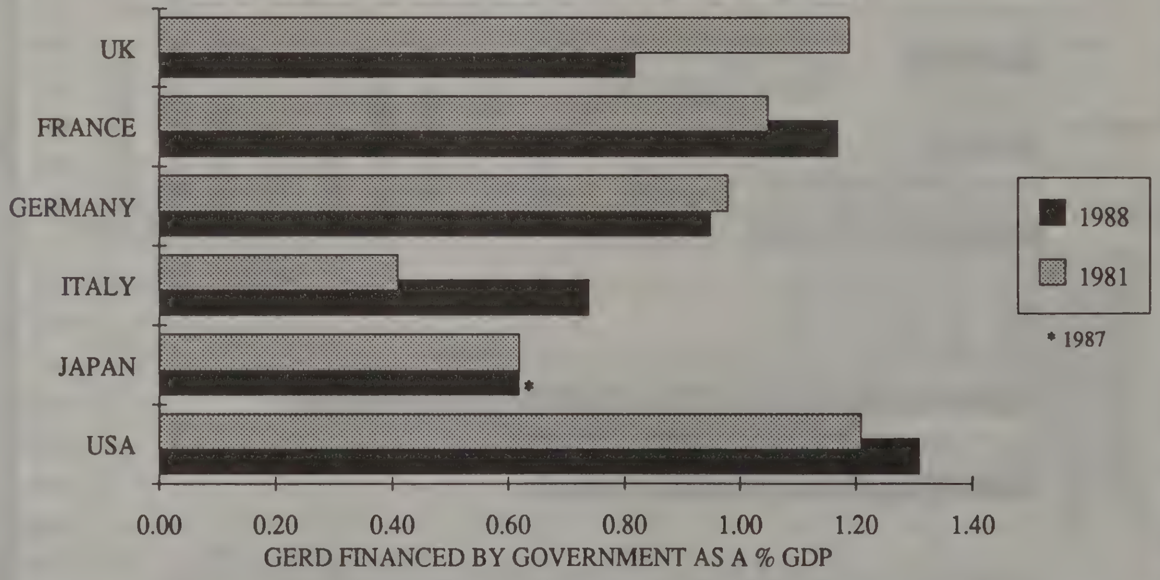
DERIVED FROM: 'MAIN SCIENCE AND TECHNOLOGY INDICATORS', OECD, PARIS, 1990.

FIG. 5: GROSS DOMESTIC EXPENDITURE ON R&D (GERD)



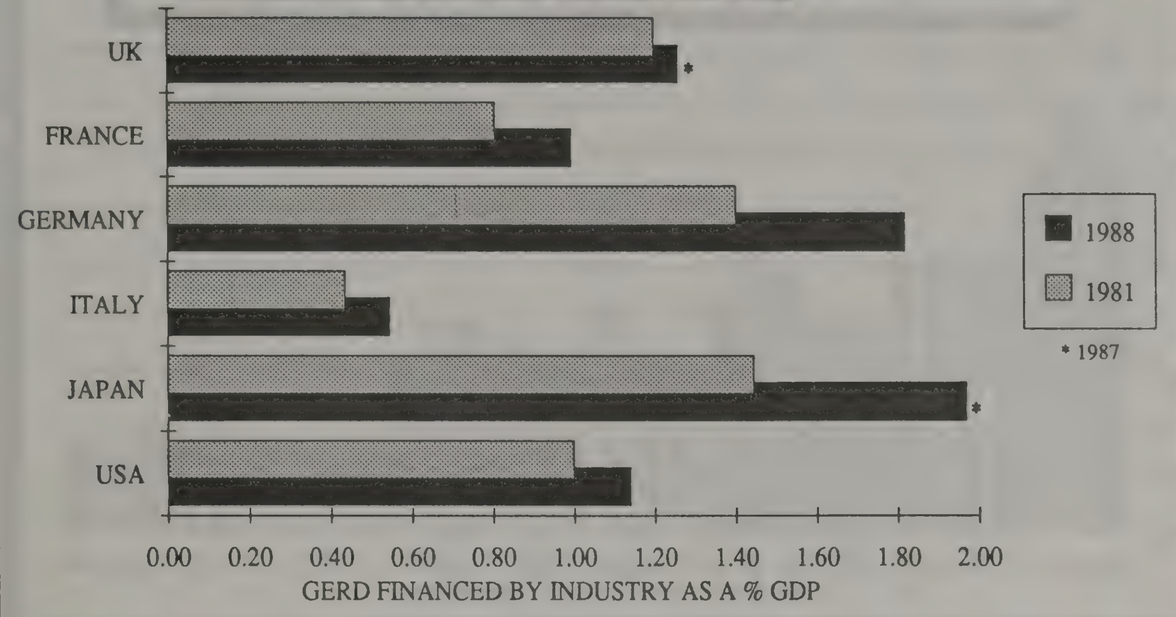
DERIVED FROM: 'MAIN SCIENCE AND TECHNOLOGY INDICATORS', OECD, PARIS, 1990 AND 'ANNUAL REVIEW OF GOVERNMENT FUNDED R&D', CABINET OFFICE, HMSO, 1990.

FIG. 6: GERD FINANCED BY GOVERNMENT



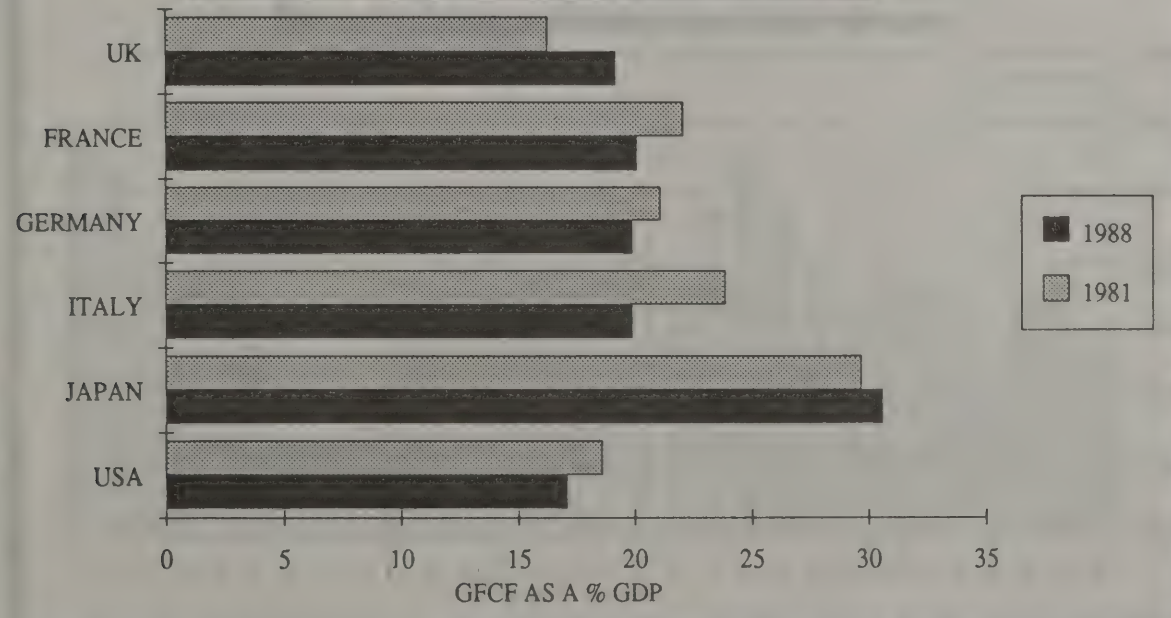
DERIVED FROM: OECD SCIENCE AND TECHNOLOGY INDICATORS, OECD, PARIS 1990 AND 'ANNUAL REVIEW OF GOVERNMENT FUNDED R&D', CABINET OFFICE, HMSO, 1990.

FIG. 7: GERD FINANCED BY INDUSTRY



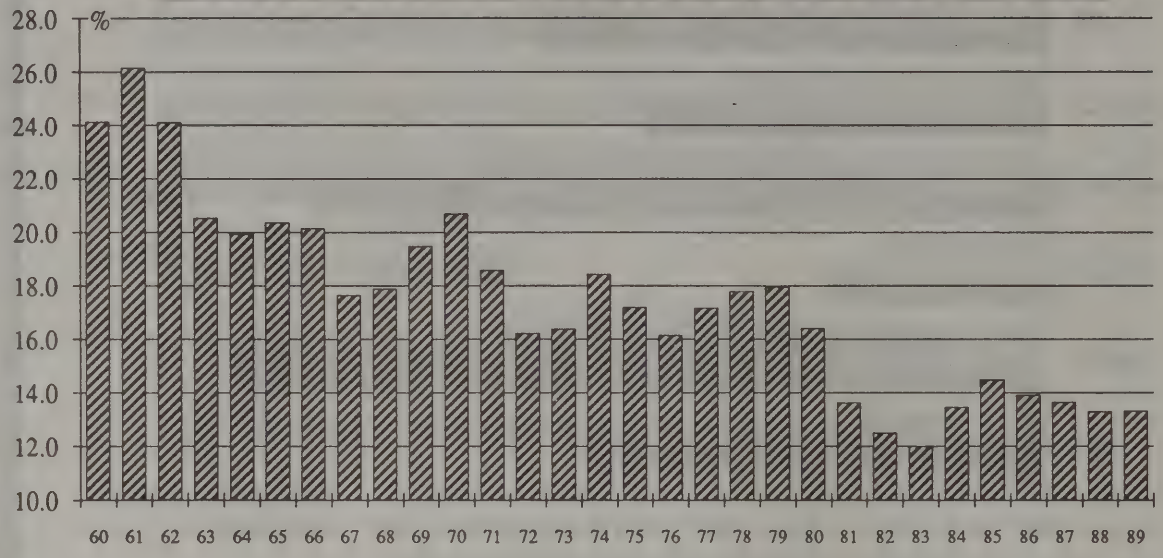
DERIVED FROM: OECD SCIENCE AND TECHNOLOGY INDICATORS, OECD, PARIS 1990.

FIG. 8: GROSS FIXED CAPITAL FORMATION



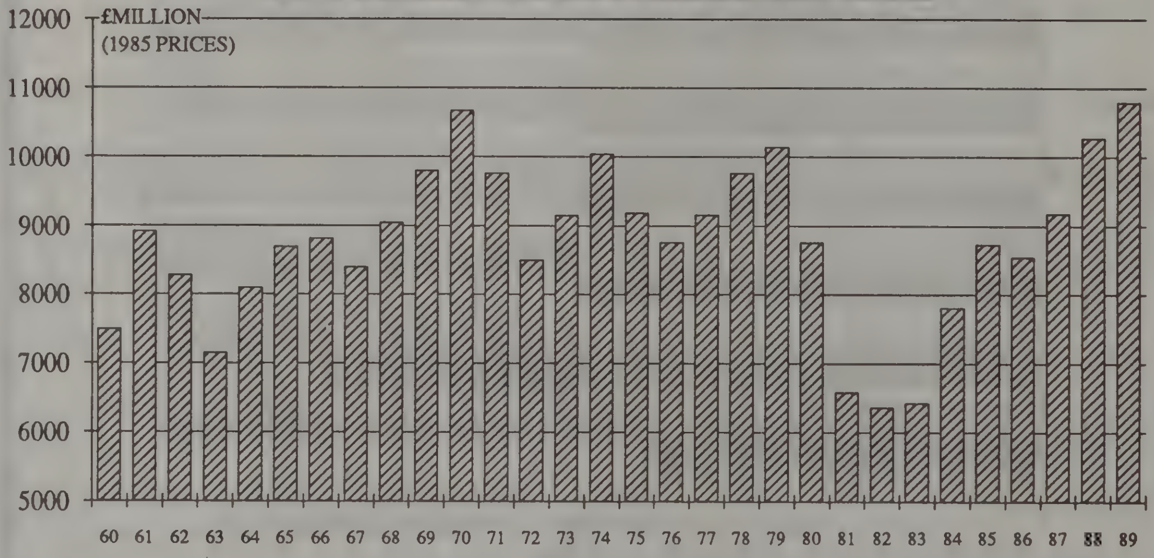
DERIVED FROM: 'NATIONAL ACCOUNTS, 1960-1988', OECD, PARIS, 1990.

FIG. 9: GROSS FIXED INVESTMENT IN UK MANUFACTURING INDUSTRY AS A PERCENTAGE OF TOTAL GFCF (1960 - 1989)



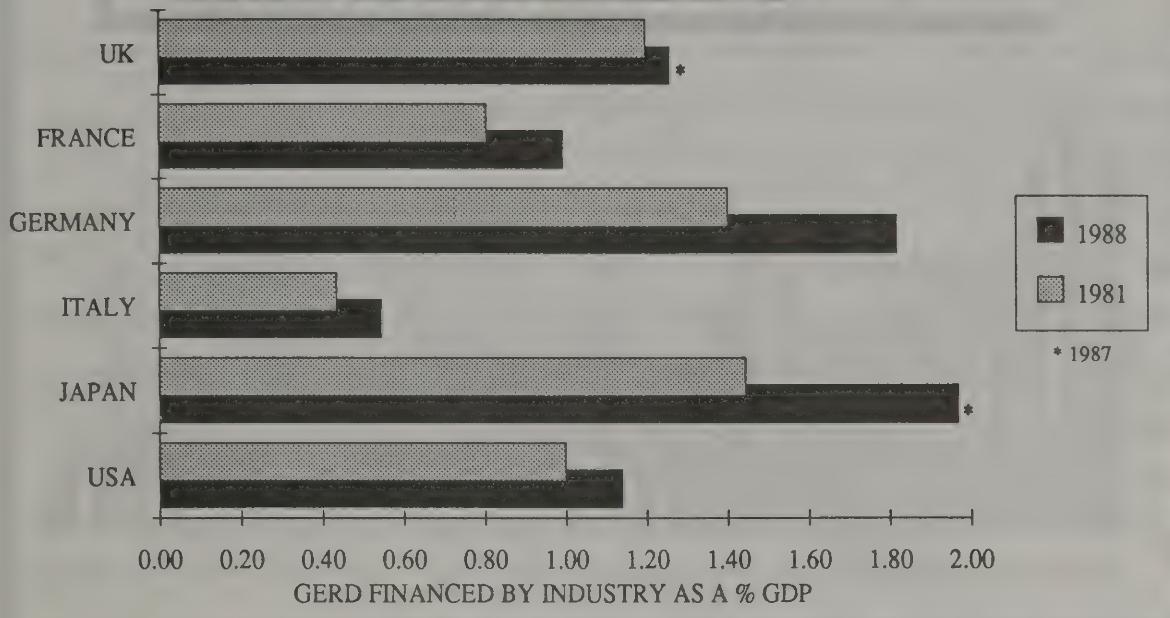
DERIVED FROM: DATA SERIES DECV & DFDM, CSO DATABASE, 7TH DECEMBER 1990.

FIG. 10: GROSS FIXED INVESTMENT IN UK MANUFACTURING INDUSTRY (1960 -1989)



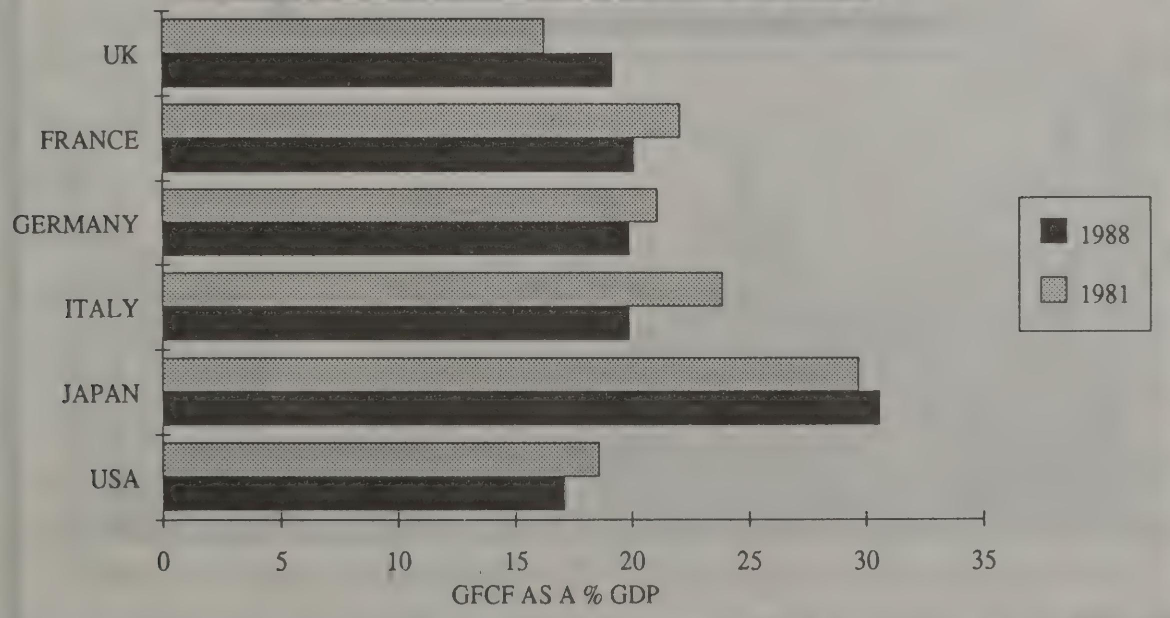
DERIVED FROM: DATA SERIES DFDN, CSO DATABASE, 7TH DECEMBER 1990.

FIG. 7: GERD FINANCED BY INDUSTRY



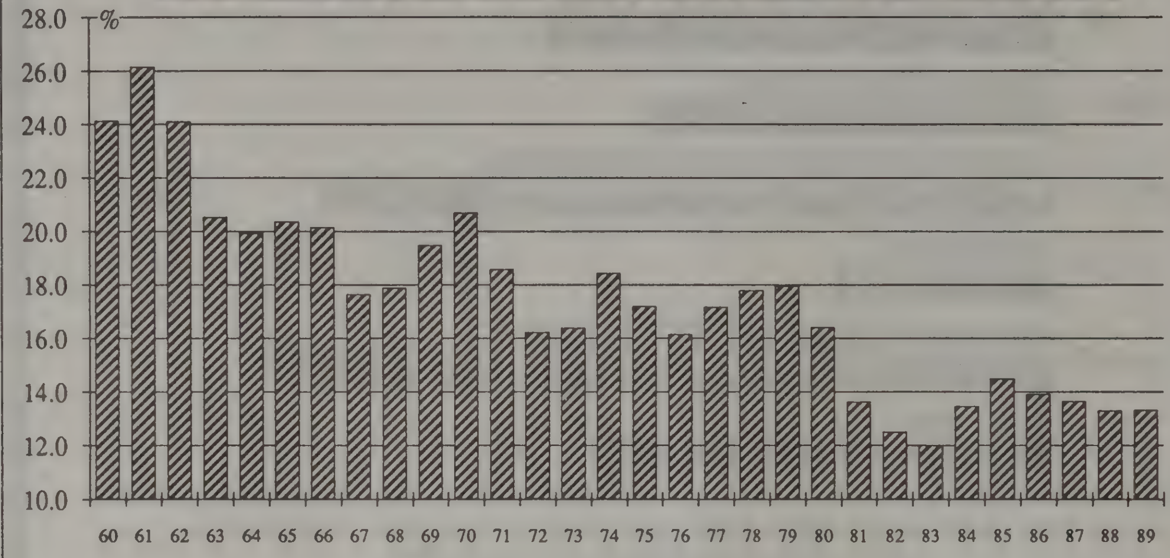
DERIVED FROM: OECD SCIENCE AND TECHNOLOGY INDICATORS, OECD, PARIS 1990.

FIG. 8: GROSS FIXED CAPITAL FORMATION



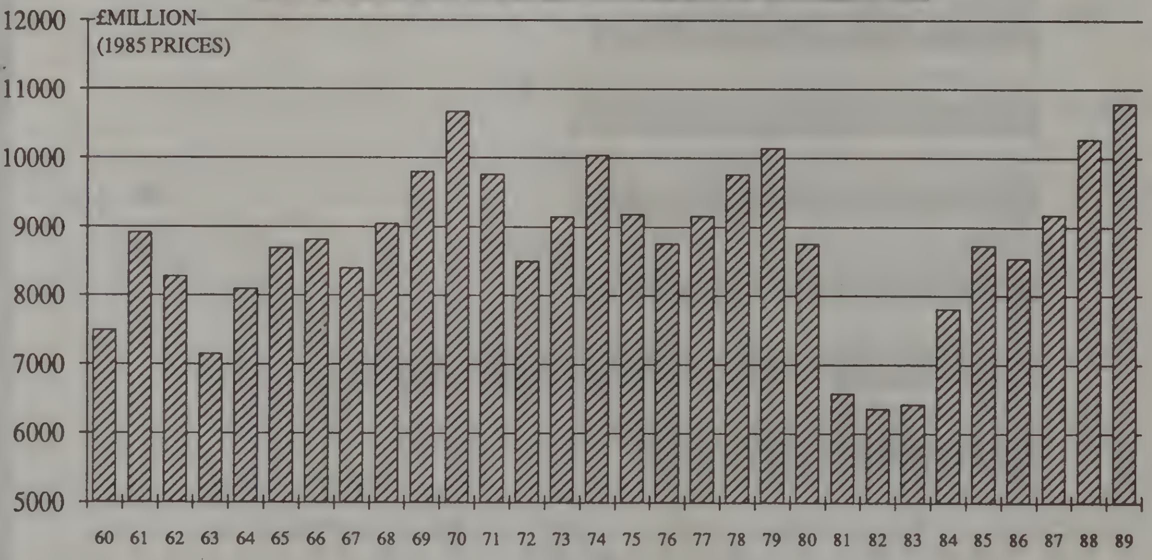
DERIVED FROM: 'NATIONAL ACCOUNTS, 1960-1988', OECD, PARIS, 1990.

FIG. 9: GROSS FIXED INVESTMENT IN UK MANUFACTURING INDUSTRY AS A PERCENTAGE OF TOTAL GFCF (1960 - 1989)



DERIVED FROM: DATA SERIES DECV & DFDM, CSO DATABASE, 7TH DECEMBER 1990.

FIG. 10: GROSS FIXED INVESTMENT IN UK MANUFACTURING INDUSTRY (1960 -1989)



DERIVED FROM: DATA SERIES DFDN, CSO DATABASE, 7TH DECEMBER 1990.

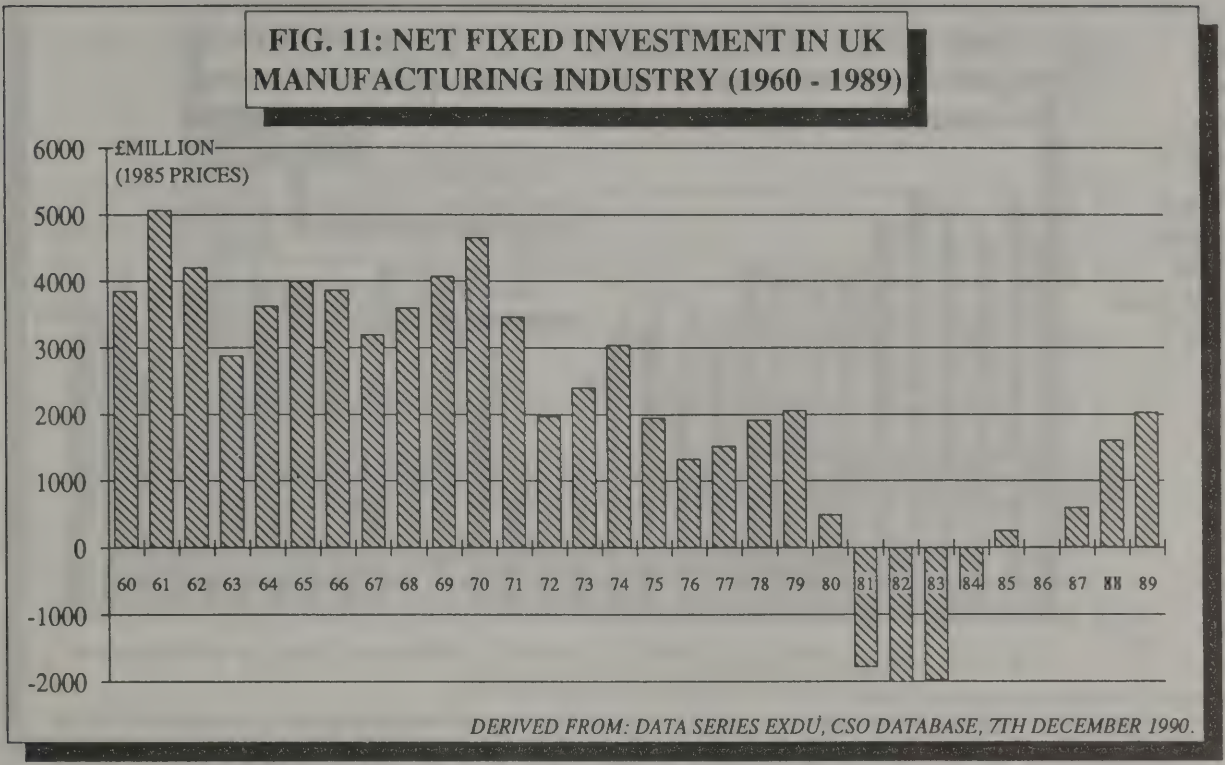


FIG. 11: NET FIXED INVESTMENT IN UK MANUFACTURING INDUSTRY (1960 - 1989)

DERIVED FROM: DATA SERIES EXDU, CSO DATABASE, 7TH DECEMBER 1990.

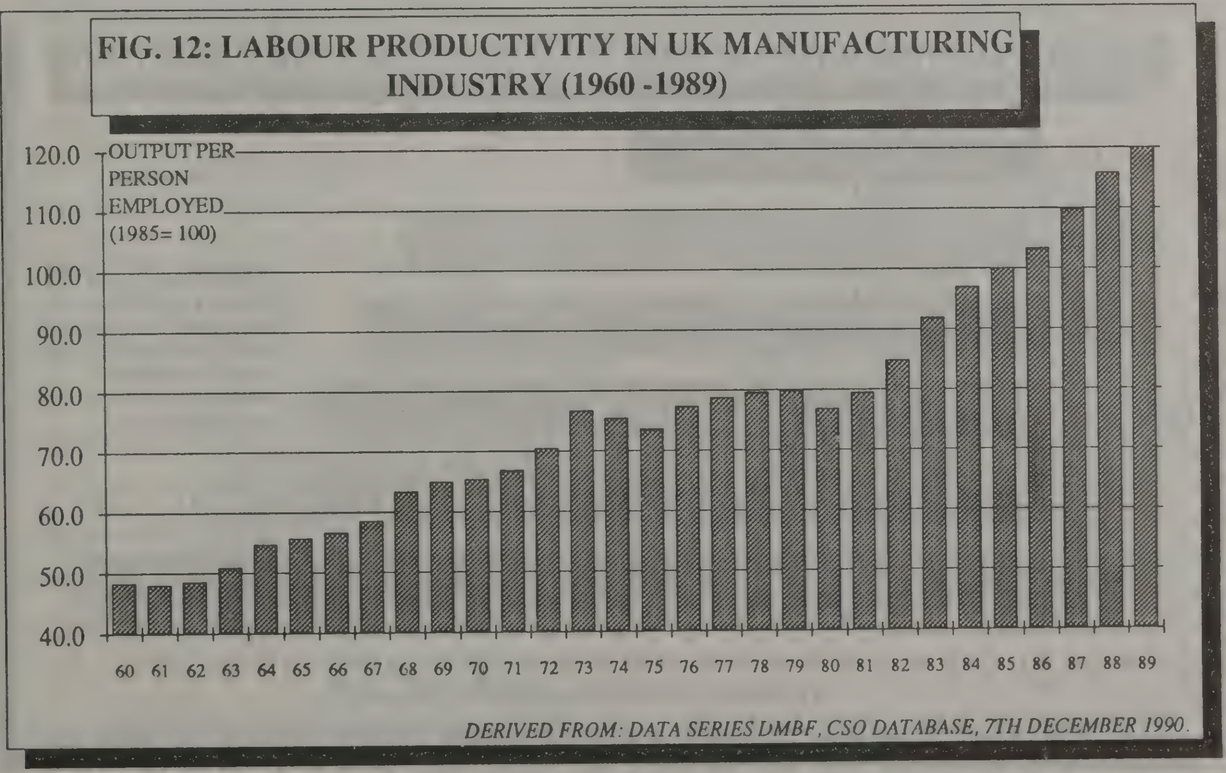


FIG. 12: LABOUR PRODUCTIVITY IN UK MANUFACTURING INDUSTRY (1960 -1989)

DERIVED FROM: DATA SERIES DMBF, CSO DATABASE, 7TH DECEMBER 1990.

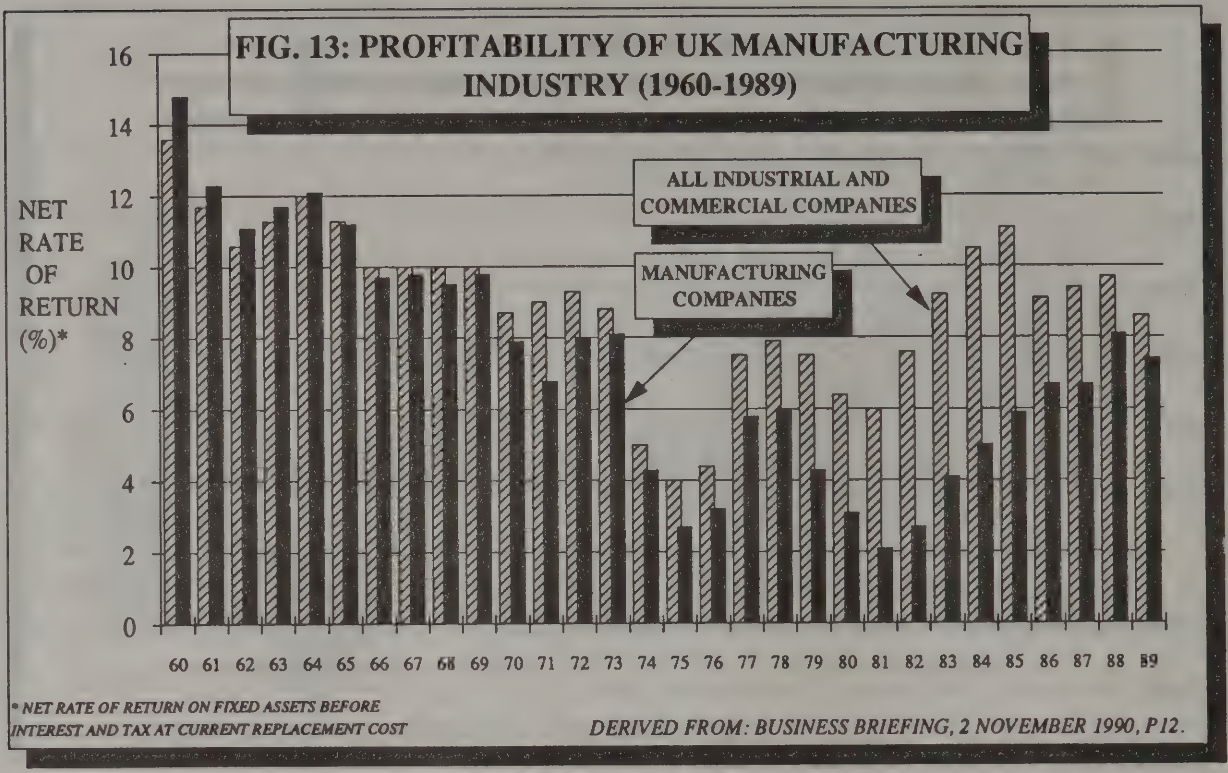


FIG. 13: PROFITABILITY OF UK MANUFACTURING INDUSTRY (1960-1989)

** NET RATE OF RETURN ON FIXED ASSETS BEFORE INTEREST AND TAX AT CURRENT REPLACEMENT COST*

DERIVED FROM: BUSINESS BRIEFING, 2 NOVEMBER 1990, P12.

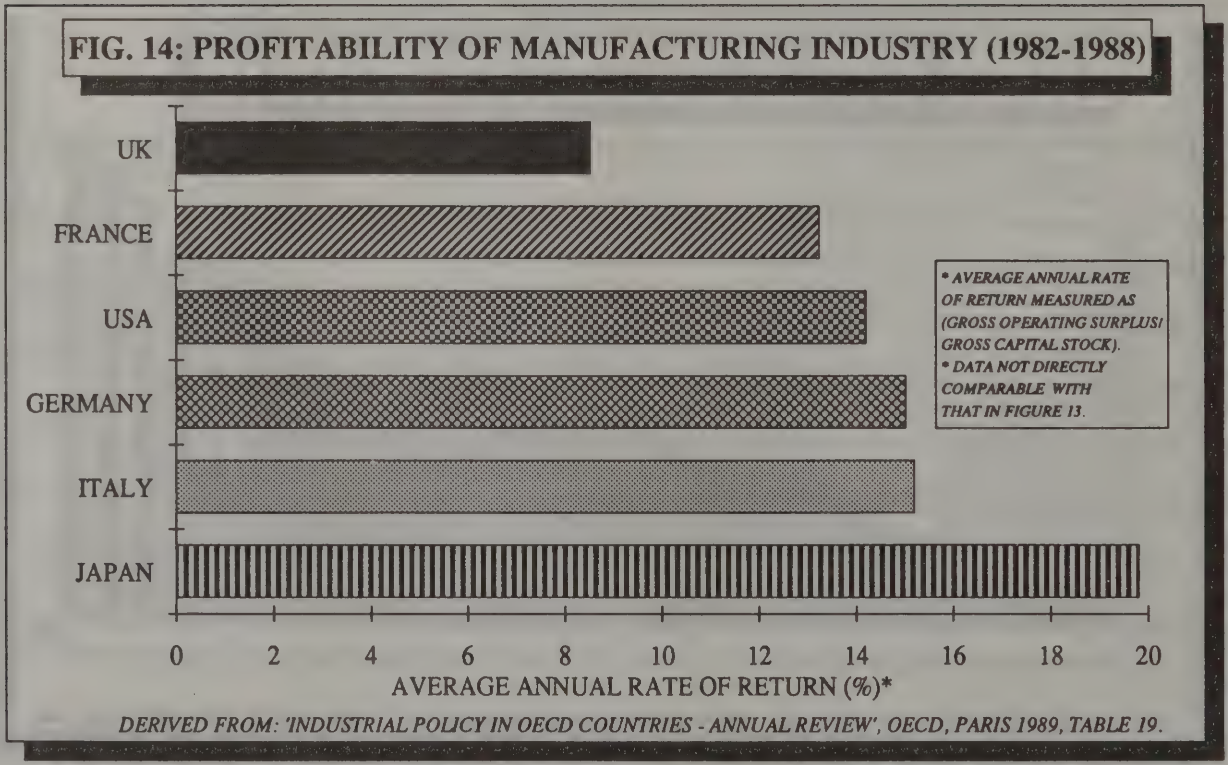
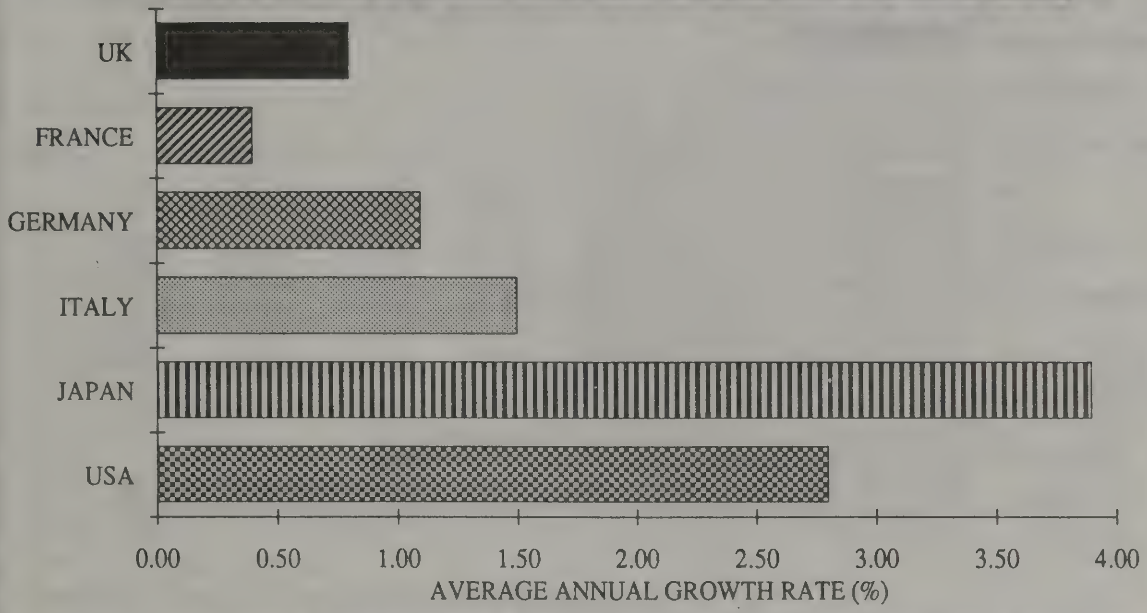


FIG. 14: PROFITABILITY OF MANUFACTURING INDUSTRY (1982-1988)

** AVERAGE ANNUAL RATE OF RETURN MEASURED AS (GROSS OPERATING SURPLUS/ GROSS CAPITAL STOCK).*
** DATA NOT DIRECTLY COMPARABLE WITH THAT IN FIGURE 13.*

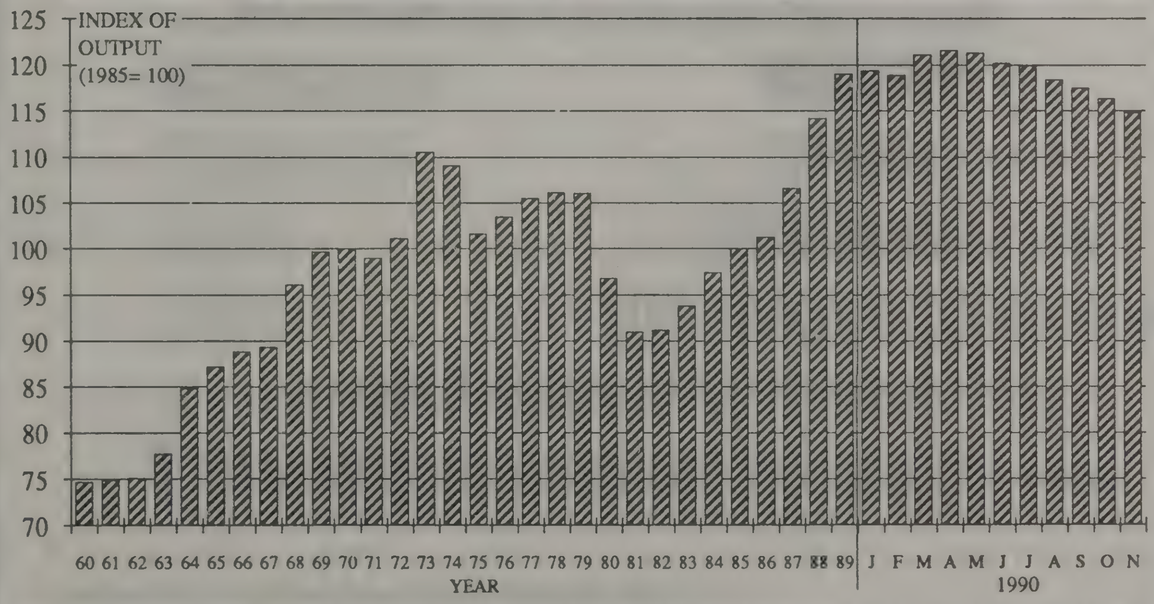
DERIVED FROM: 'INDUSTRIAL POLICY IN OECD COUNTRIES - ANNUAL REVIEW', OECD, PARIS 1989, TABLE 19.

FIG. 15: GROWTH IN MANUFACTURING OUTPUT (1979-88)



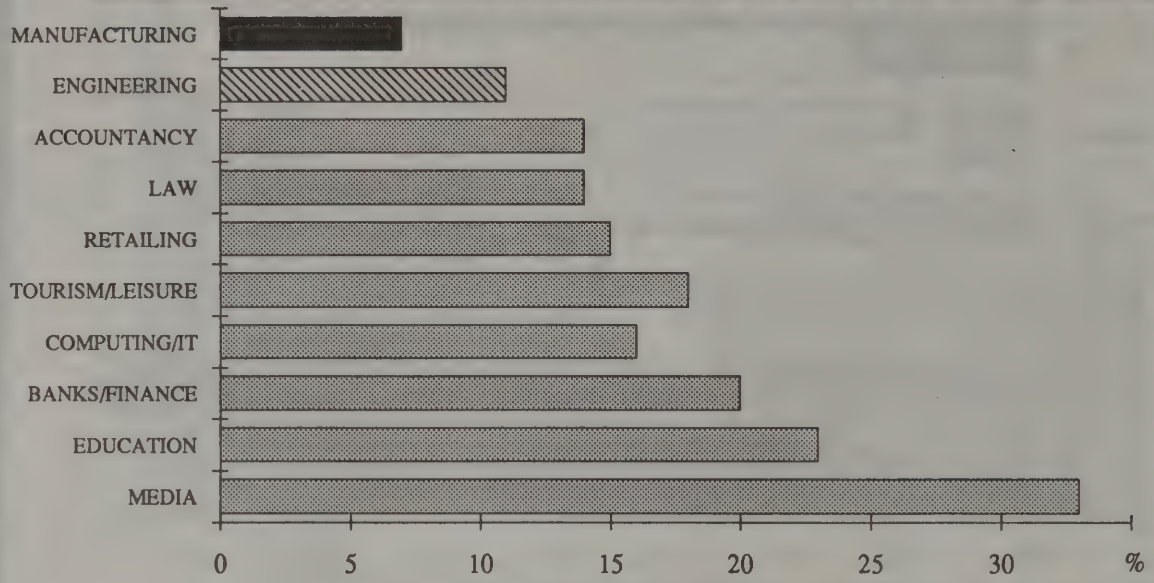
DERIVED FROM: 'MANUFACTURING INTO THE LATE 1990's', DTI/PA CONSULTING GROUP, HMSO, 1989.

FIG. 16: INDEX OF OUTPUT OF MANUFACTURING INDUSTRY (1960-90)



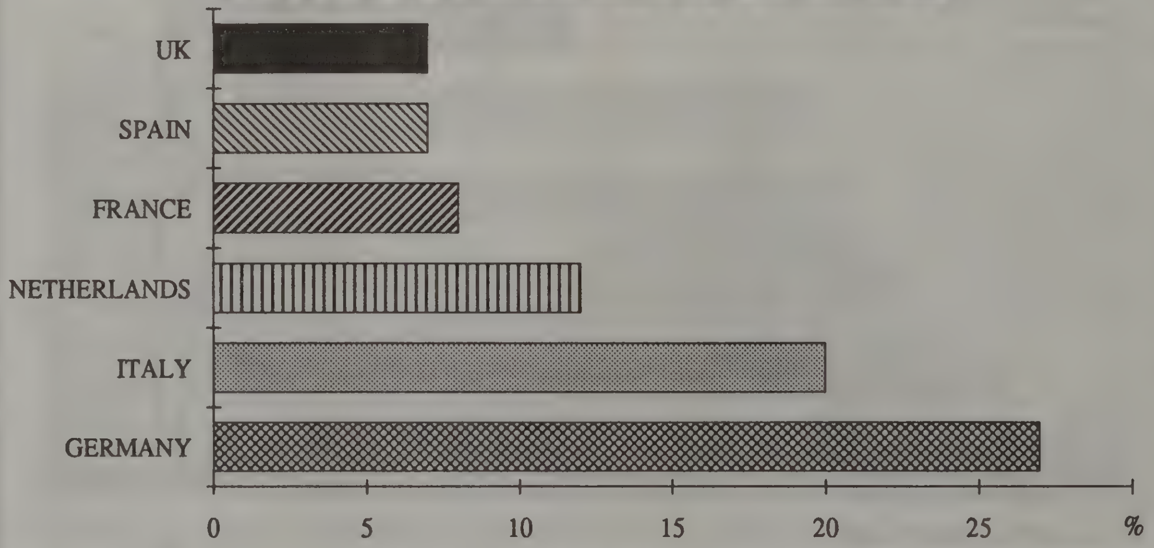
DERIVED FROM: DATA SERIES DVIS, CSO DATABASE, 7TH DECEMBER 1990 & CSO (91)10, 21ST JANUARY 1991.

FIG. 17: CAREERS SERIOUSLY CONSIDERED BY UK STUDENTS (1990)



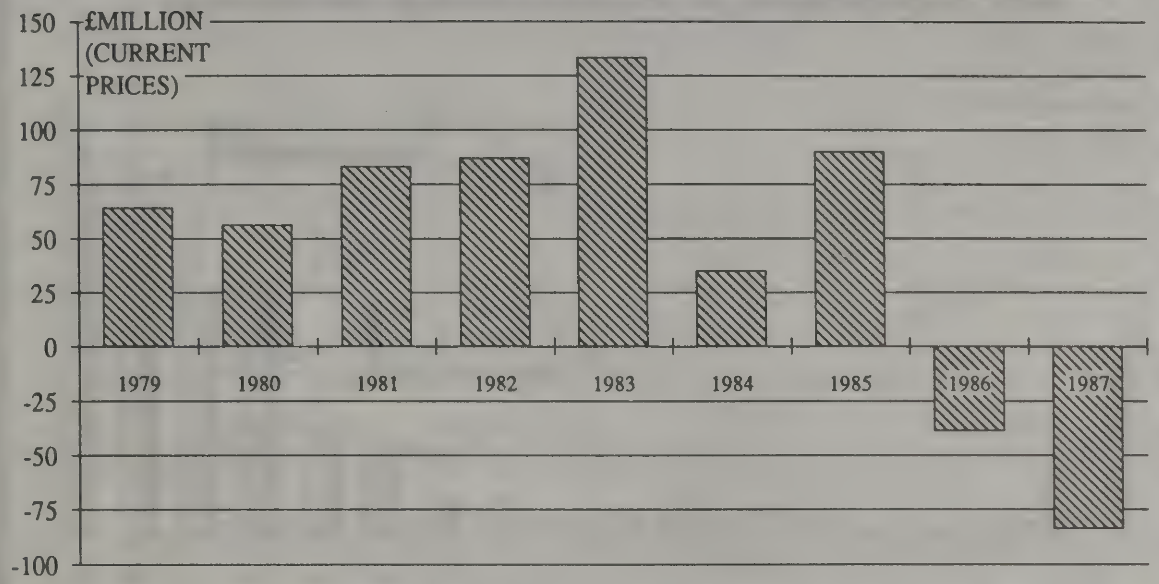
DERIVED FROM: 'EUROPEAN STUDENTS' ATTITUDES TO BUSINESS', RESEARCH SURVEYS OF GREAT BRITAIN LTD, REPORT NO. JN5896, 1990.

FIG. 18: STUDENTS SERIOUSLY CONSIDERING MANUFACTURING AS A CAREER (1990)



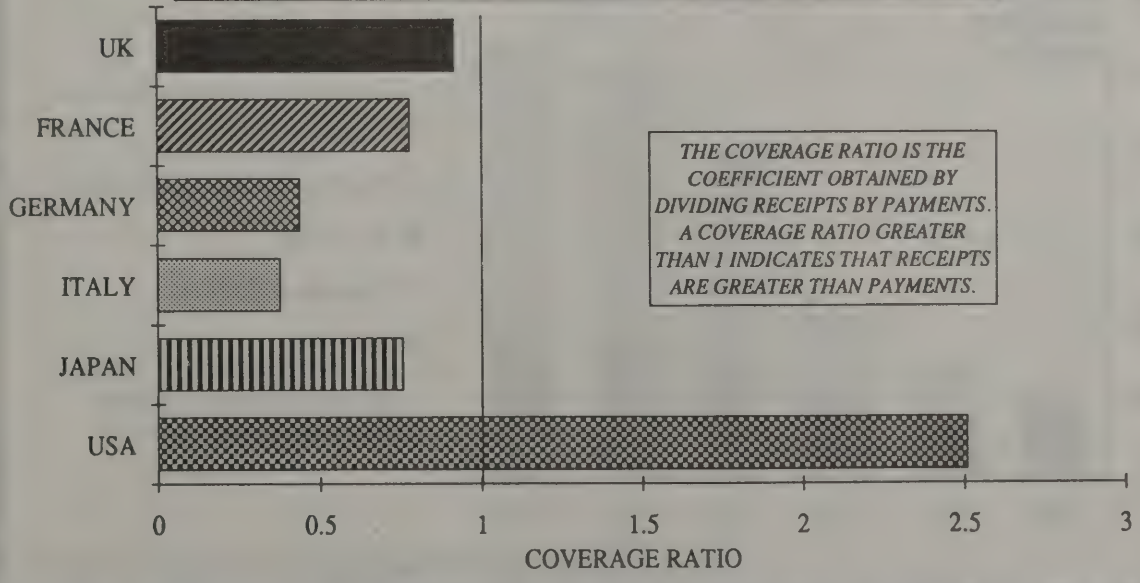
DERIVED FROM: 'EUROPEAN STUDENTS' ATTITUDE TO BUSINESS', RESEARCH SURVEYS OF GREAT BRITAIN LTD, REPORT No. JN5896, 1990.

FIG. 19: UK TECHNOLOGICAL BALANCE OF PAYMENTS (1979-87)



DERIVED FROM: 'MAIN SCIENCE AND TECHNOLOGY INDICATORS', OECD, PARIS, 1990.

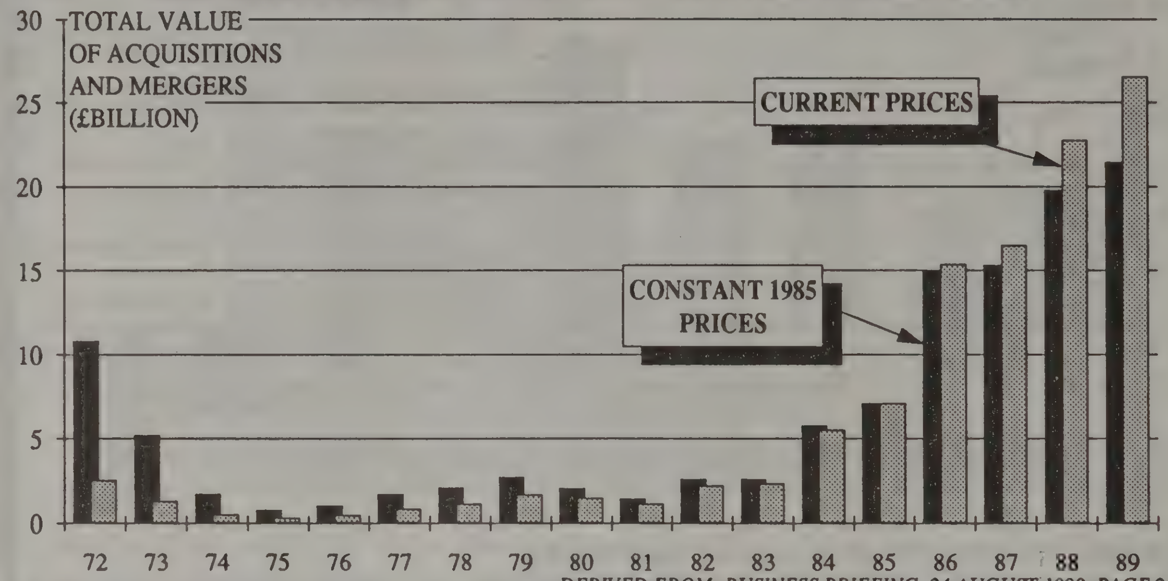
FIG. 20: TECHNOLOGICAL BALANCE OF PAYMENTS COVERAGE RATIO (1987)



THE COVERAGE RATIO IS THE COEFFICIENT OBTAINED BY DIVIDING RECEIPTS BY PAYMENTS. A COVERAGE RATIO GREATER THAN 1 INDICATES THAT RECEIPTS ARE GREATER THAN PAYMENTS.

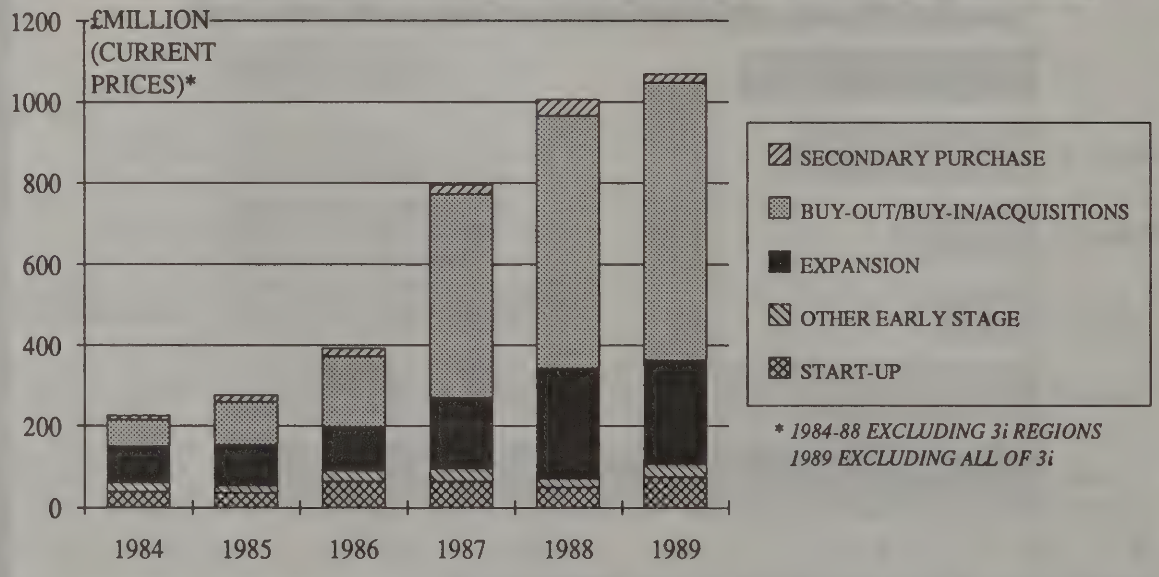
DERIVED FROM: 'MAIN SCIENCE AND TECHNOLOGY INDICATORS, OECD, PARIS.

FIG. 21: ACQUISITIONS AND MERGERS WITHIN THE UK (INDUSTRIAL AND COMMERCIAL COMPANIES)



DERIVED FROM: BUSINESS BRIEFING, 24 AUGUST 1990, PAGE 24.

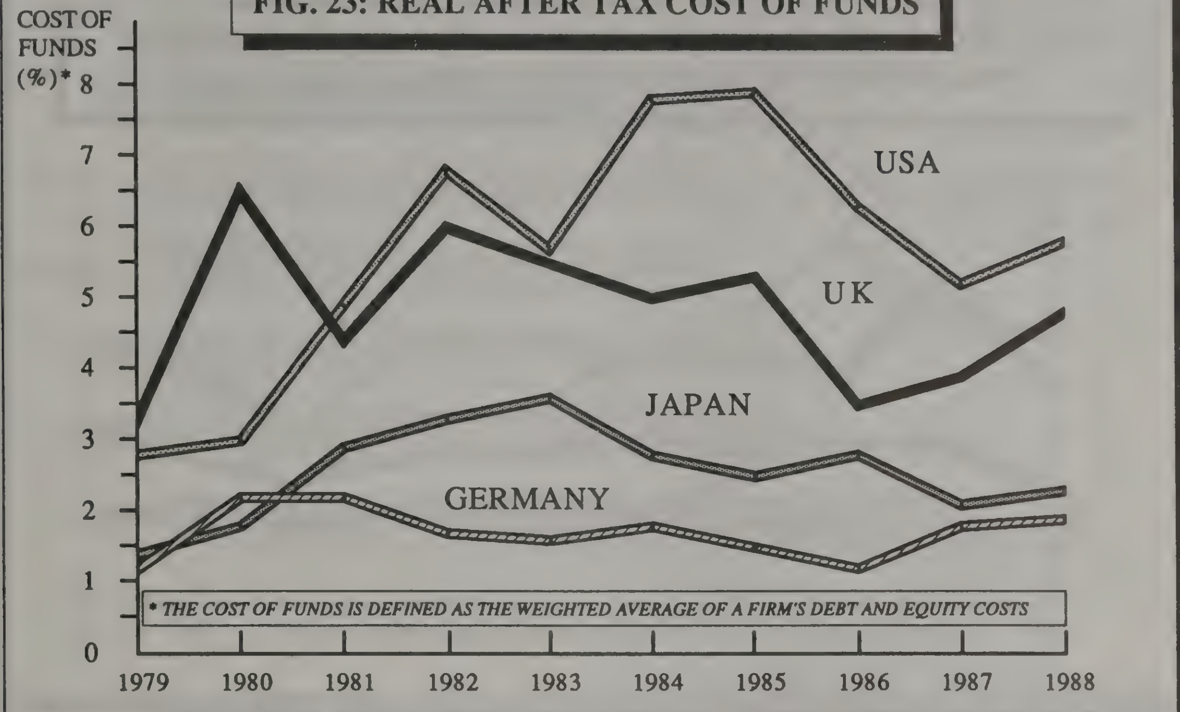
FIG. 22: UK VENTURE CAPITAL INVESTMENT ACTIVITY (1984-89)



** 1984-88 EXCLUDING 3i REGIONS*
1989 EXCLUDING ALL OF 3i

DERIVED FROM: BANK OF ENGLAND QUARTERLY BULLETIN, FEBRUARY 1990, TABLE 2, PAGE 79, AND DATA SUPPLIED BY VENTURE ECONOMICS LTD.

FIG. 23: REAL AFTER TAX COST OF FUNDS



* THE COST OF FUNDS IS DEFINED AS THE WEIGHTED AVERAGE OF A FIRM'S DEBT AND EQUITY COSTS

DERIVED FROM: FEDERAL RESERVE BANK OF NEW YORK, QUARTERLY REVIEW, SUMMER 1989, CHART 6.

FIG. 24: ESTIMATED COST OF CAPITAL FOR EQUIPMENT AND MACHINERY WITH A PHYSICAL LIFE OF 20 YEARS

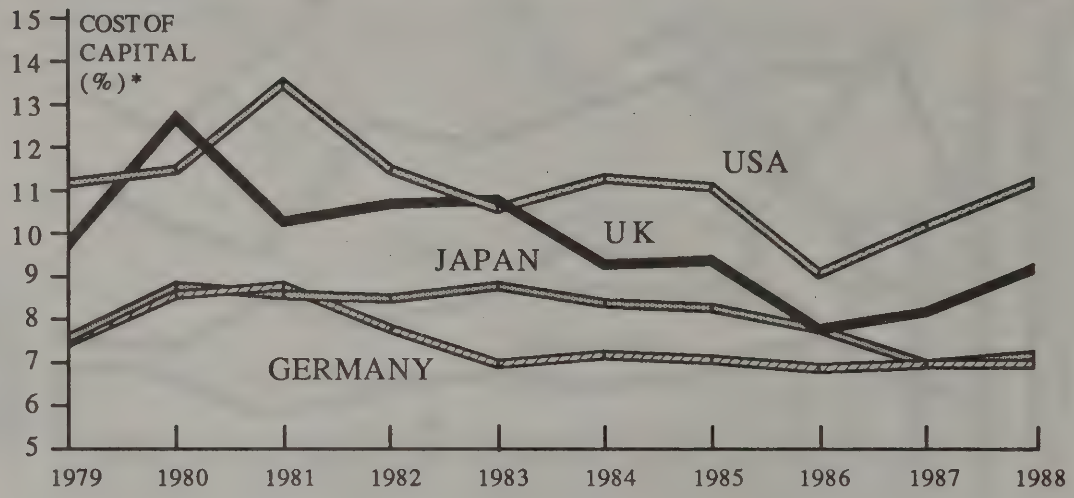
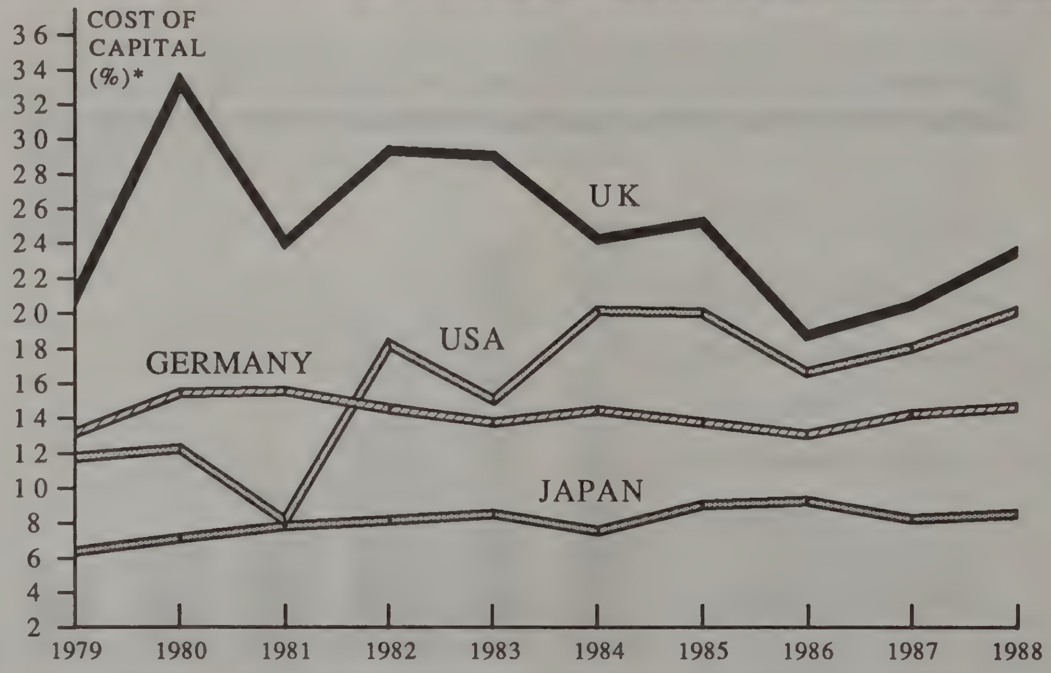


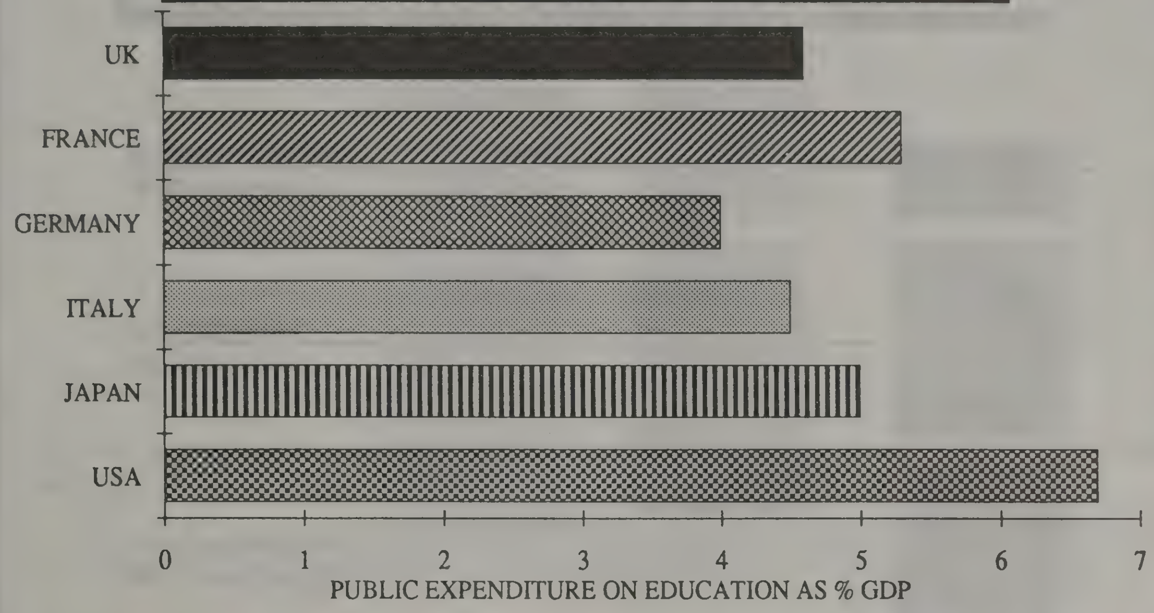
FIG. 25: ESTIMATED COST OF CAPITAL FOR AN R&D PROJECT WITH A TEN YEAR PAYBACK PERIOD



** THE COST OF CAPITAL IS THE MINIMUM BEFORE-TAX REAL RATE OF RETURN THAT AN INVESTMENT PROJECT MUST GENERATE IN ORDER TO MEET ITS FINANCING COSTS AFTER TAX LIABILITIES. THE COST OF CAPITAL IS A FUNCTION OF (i) THE COST OF FUNDS, (ii) THE ECONOMIC DEPRECIATION OF THE INVESTMENT, (iii) THE TAX TREATMENT OF THAT DEPRECIATION, (iv) THE TAXATION OF CORPORATE EARNINGS, AND (v) ANY FISCAL INCENTIVES FOR INVESTMENT.*

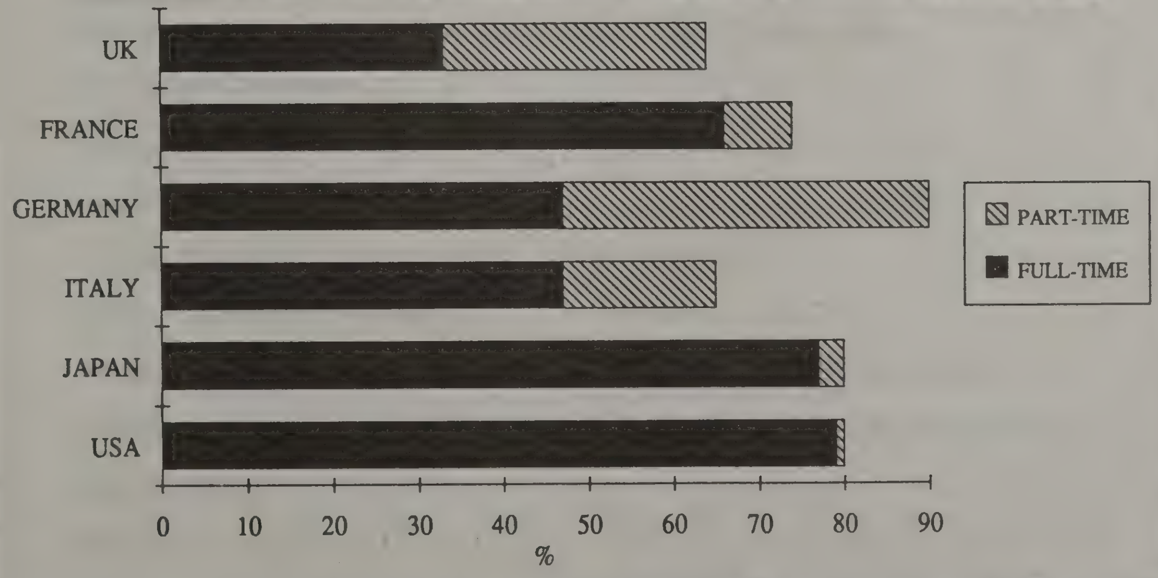
DERIVED FROM: FEDERAL RESERVE BANK OF NEW YORK, QUARTERLY REVIEW, SUMMER 1989, TABLE 2.

FIG. 26: PUBLIC EXPENDITURE ON EDUCATION (1986)



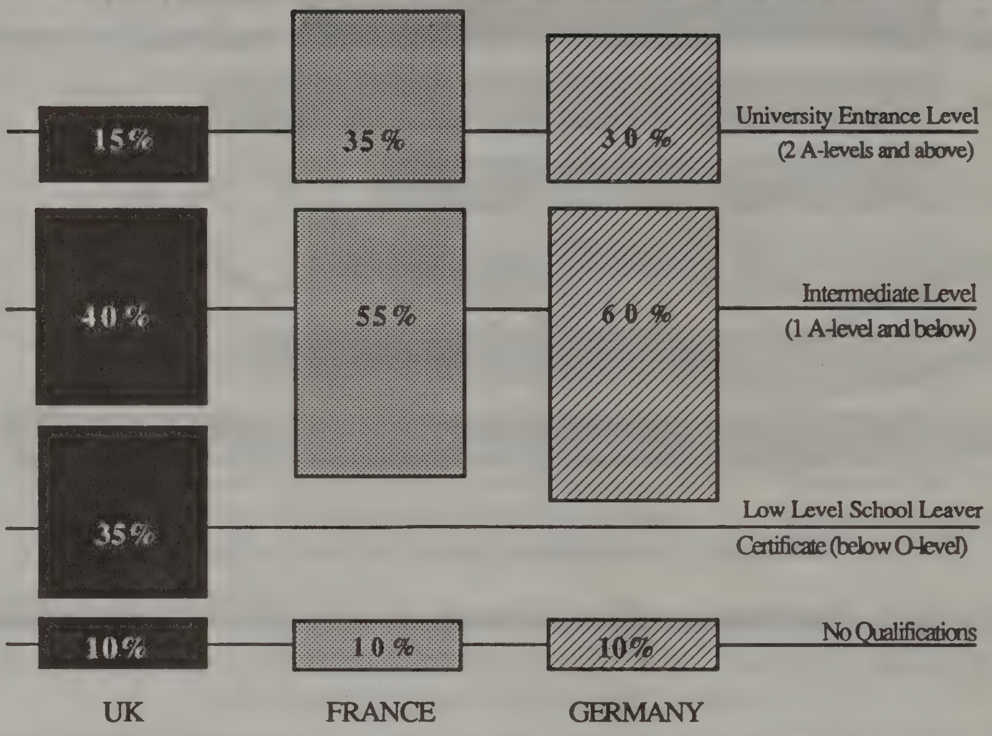
SOURCE: UNESCO STATISTICAL YEARBOOK, 1989.

FIG. 27: COMPARISON OF PARTICIPATION RATES OF 16-18 YEAR OLDS IN EDUCATION AND TRAINING (1986)



DERIVED FROM: DES STATISTICAL BULLETIN, 1/90, 1990.

FIG. 28: HIGHEST QUALIFICATIONS OF SCHOOL LEAVERS



DERIVED FROM: 'TOWARDS A SKILLS REVOLUTION', CBI, 1990, EXHIBIT 6, P18.

APPENDIX 1

Sub-Committee I—Innovation in Manufacturing Industry

The members of the Sub-Committee who conducted the enquiry were:

L. Butterworth
V. Caldecote (Chairman)
L. Chapple
L. Chorley
L. Clitheroe
L. Erroll of Hale
L. Flowers
L. Gregson
L. Kearton
L. Taylor of Gryfe
L. Vinson
L. Whaddon

The Sub-Committee appointed as their Specialist Advisers:

Oscar Roith Esq, former Chief Engineer and Scientist at the Department of Trade and Industry;

Professor Roy Rothwell, Director of the Technology and Innovative Management Programme at the Science Policy Research Unit, University of Sussex.

APPENDIX 2

List of witnesses

The following witnesses gave evidence. Those marked * gave oral evidence.

Agricultural and Food Research Council

Sir Geoffrey Allen, FRS

Association of the British Pharmaceutical Industry

Association of Independent Research and Technology Organisations

W S Atkins Consultants Ltd

Barclays Bank plc

*Sir William Barlow

Dr Paul Bate, School of Management, University of Bath

*Beaver Engineering Group plc

Professor John Bessant, Centre for Business Research, Brighton Polytechnic

*Professor S K Bhattacharyya, Department of Engineering, University of Warwick

BICC Group plc

*BOC Group

Britax Automotive Components Division, BSG International plc

*British Aerospace plc

British Clothing Industry Association Ltd

British Footwear Manufacturers' Federation

British Petroleum

British Radio and Electronic Equipment Manufacturers' Association

British Steel

Brown & Root (UK) Ltd

Dr D W Budworth

*Cambridge Instruments Ltd

Sir Charles Carter

*Celltech Ltd

Centre for Exploitation of Science and Technology

Chemical Industries Association Ltd

Committee of Directors of Polytechnics

Committee of Vice-Chancellors and Principals

*Confederation of British Industry

*Coopers & Lybrand Deloitte

*Sir Brian Corby, President, Confederation of British Industry

Defence Manufacturers' Association

Defence Technology Enterprises Ltd

Design Council

*Department of Trade and Industry

Electra Innvotec

Electronic Components Industry Federation

Electronics and Business Equipment Association

Engineering Council

Engineering Employers' Federation

*Eurotherm International plc

Federation of British Electrotechnical and Allied Manufacturers' Association

*Fellowship of Engineering

*Fisons plc

Flexible Manufacturing Technology Ltd

Food and Drink Federation

Sir Hugh Ford and Associates Ltd

*General Electric Company plc

GKN plc

Glaxo

*Sir John Harvey-Jones, MBE

ICI Group

Inland Revenue

Institution of Production Engineers

Institutional Fund Managers' Association

*3i plc

Japan-Europe Industry Research Centre, Imperial College of Science, Technology and Medicine

*Kleinwort Benson Investment Management Ltd

KPMG Peat Marwick McLintock

*Rt Hon Peter Lilley, MP, Secretary of State for Trade and Industry

London Business School

*Lucas Industries plc

Machine Tool Technologies Association

Manchester Business School

Medical Research Council

*Mercury Asset Management Group plc

Professor J S Metcalfe, Department of Economics, University of Manchester

Ministry of Agriculture, Fisheries and Food

MSF—Manufacturing, Science and Finance Union

National Economic Development Council

*Sir Robin Nicholson, FEng, FRS

R P Oakey, Department of Business Organisation, Heriot Watt University

J P O'Connor

Professor J M Owen, School of Mechanical Engineering, University of Bath

*Oxford Instruments Group

*PA Consulting

Professor Keith Pavitt, Science Policy Research Unit, University of Sussex

*Philips Components Ltd

James Pilditch, CBE

Policy Studies Institute

*Professor Michael E Porter, Harvard Business School

*Prudential Portfolio Managers Ltd

*Quantel

Queen's University of Belfast

Quo-Tec Ltd

Dr D H Roberts, Provost, University College London

*Lord Roll of Ipsden

Royal Society of Chemistry

Professor John Saunders, Department of Management Studies, Loughborough University of Technology

*SmithKline Beecham

Science and Engineering Research Council

Society of British Aerospace Companies Ltd

Society of Motor Manufacturers and Traders Ltd

Trades Union Congress

University of Salford/CAMPUS

Dr C E Webb, Department of Physics, University of Oxford

Professor J C Wilmott, Office of Research and Technology Transfer, University of Manchester

APPENDIX 3

List of abbreviations

ABPI	Association of British Pharmaceutical Industry
ACOST	Advisory Council on Science and Technology
AFRC	Agricultural and Food Research Council
AIRTO	Association of Independent and Technology Research Organisations
BEAMA	Federation of British Electrotechnical and Allied Manufacturers' Associations
BP	British Petroleum
BERD	Business Enterprise R&D
BRITE/EURAM	Basic Research in Industrial Technologies for Europe/European Research in Advanced Materials
CBI	Confederation of British Industry
CDP	Committee of Directors of Polytechnics
CVCP	Committee of Vice-Chancellors and Principals
DTI	Department of Trade and Industry
ECIF	Electronic Components Industries Federation
EEA	Electronics and Business Equipment Association
ESPRIT	Strategic Programme for Research in Information Technology
EUREKA	European Research Co-ordination Agency
FDF	Food and Drink Federation
GERD	Government Expenditure on R&D
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formation
HEIs	Higher Education Institutions
HMSO	Her Majesty's Stationery Office
IFMA	Institutional Fund Managers' Association
MBA	Master of Business Administration
MRC	Medical Research Council
NEDO	National Economic Development Office
OECD	Organisation for Economic Co-operation and Development
RACE	Research in Advanced Communications in Europe
SFI	Support for Innovation
SMEs	Small- and Medium-sized Enterprises
SMMT	Society of Motor Manufacturers and Traders
SPUR	Support for Products Under Research
TUC	Trades Union Congress

APPENDIX 4

REVIEW OF DTI EXPENDITURE 1981-1990[1]

1. INTRODUCTION

DTI expenditure data (Tables 1-4) was obtained from "The Government's Expenditure Plans" (PES), 1981-1989, and through correspondence with the DTI.

In this Appendix information about expenditure by the DTI over a period of years has been brought together. This has not been done before. Inevitably apparent trends in expenditure reflect changes in the responsibilities and structure of the Department, and in Government policy. For example the Secretary of State for Trade and Industry no longer has responsibility for industries which have been privatised during the period in question. Although the information has limitations and must therefore be treated with caution, it does nevertheless clearly illustrate general trends in Government's relations with industry.

The 1990 PES divides DTI expenditure (i.e. that provided by central Government) into the following categories:

1. Regional and general industrial support (including business development and inner cities).
2. Support for aerospace, shipbuilding and steel, and vehicle manufacture (including Launch Aid).
3. Support for industry (including innovation and space).
4. International trade.
5. Statutory and regulatory work (including technological support) and consumer protection.
6. Central and miscellaneous services.
7. Other non-voted expenditure, which in the past consisted mainly of receipts from Nationalised Industries (since 1986-87 these have been zero).

A more detailed breakdown of the DTI expenditure categories is shown in Figure 1.

In 1988-89 total DTI expenditure of approximately £1,652 million was broken down between the different support schemes as shown in Figure 2. This expenditure was £152 million less than estimated due to underspend on the following programmes:

(i) Launch aid: delays in the commencement of the A330-A340 project meant that payments started later than expected.

(ii) Support for Industrial R&D: major policy changes announced in January 1988 have resulted in a slower than expected build-up of expenditure under the new collaborative programmes.

(iii) Business Development: it took longer than expected for projects under the new consultancy initiatives to progress from inception to payment; take-up of the new Regional Enterprise Grants also proved slow.

The trend in total DTI expenditure over the period 1981 to 1990 is shown in Figure 3. This reveals that DTI expenditure decreased, both in cash and real terms, over the period 1981-82 to 1987-88, increased in 1988-89 and is projected to fall steadily from 1988-89 onwards.

As discussed below the composition of DTI expenditure has changed quite markedly over the period of interest.

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[1] The former Departments of Industry and Trade were combined in June 1983 to form the DTI.

2. Regional and general industrial support (PES Category 1)

This covers principally Regional Selective Assistance (RSA) to individual firms and undertakings (non cash-limited), together with the Business Development Initiative and the Inner Cities Initiative (both cash-limited). RSA continues to be available in Assisted Areas (i.e. in Development and Intermediate Areas) throughout Great Britain for projects which meet the scheme's criteria and is now the main form of regional industrial assistance. The programme also covers the residual costs of the Regional Development Grant (RDG) scheme which closed for applications on 31 March 1988, and provision for selective assistance to industry.

Expenditure in 1988-89 was £395 million. However Figure 4 shows a continuing decline in "Regional and General Industrial Support", both in cash and real terms, over the period of interest.

2.1 *Selective Assistance to Individual Industries, Firms and Undertakings*

Assistance is no longer available under the Support for Major Projects Scheme, the Microelectronics Industries Support Programme, the Fibre Optics Scheme, the Flexible Manufacturing System Support Scheme and the Quality Assurance Support Scheme. However support under Assistance for Exceptional Projects (AEP), which replaced Support for Major Projects, continues to be available to a limited number of investment projects which are likely to provide exceptional national benefits and which would not otherwise go ahead. As the DTI note "by their nature such projects are likely to be few and far between" and only two applications have been successful to date. Provision for this scheme is £5.0 million in 1990-91 rising to £5.1 million in 1992-93.

3. Support for aerospace, shipbuilding and steel (PES Category 2)

This covers launch aid for civil aerospace projects; support for shipbuilding through the Home Shipbuilding Credit Guarantee Scheme and the Intervention Fund; together with payments under the Iron and Steel Employees Re-adaptation Benefits Scheme.

Expenditure in 1988-89 totalled £668 million. With the exception of the financial years 1986-87 and 1988-89 expenditure on programmes within this category decreased quite markedly during the 1980s, Figure 5.

3.1 *Launch Aid*

Launch aid is provided for civil aerospace projects on terms which entitle the Government to receive levies on the sales of aircraft whose development has been assisted. Estimated expenditure of £99.1 million 1989-90 is partly offset by levy receipts of £22.4 million.

Table 4 and Figure 6 show the trend in net launch aid (i.e. expenditure less levy receipts): expenditure fell sharply in 1982-83 but then increased steadily until 1986-87. Although the sharp fall in 1987-88 was followed by another steady increase, the 1990 Expenditure Plans indicate that launch aid expenditure is expected to come to an end by 1992-93.

4. Support for industry (PES Category 3)

This programme covers assistance for: Industrial Innovation (now focussed on support for longer term collaborative research and the encouragement of technology transfer); Civil Space Research and Development (concentrated on European Space Agency (ESA) programmes); Civil Aircraft Research and Demonstration; Education and Training; and Other Support Services (including action to encourage business and education to work together)—see Figure 1 for a more detailed breakdown into the different sub-categories.

Total expenditure on "Support for Industry" was £274 million in 1988-89, with the two major sub-categories, "Industrial Innovation" and "Space", accounting for £109 million and £80 million respectively. A more detailed description of the current support programmes is given in *The Government's Expenditure Plans 1990,* Chapter 4, Trade and Industry, paragraphs 35-51.

Figure 7 shows that expenditure on "Support for Industry" increased quite sharply between 1981-82 and 1983-84, but then declined in real terms before stabilising at approximately £270 million.

Table 2 shows the breakdown of expenditure into the different schemes that make up "Support for Industry". Significantly the sum of the individual components of Table 2 does not equal the total DTI expenditure on "Support for Industry" given in Table 1.[1] One of the major difficulties in trying to examine the trend in expenditure on the different schemes that make up "Support for Industry" is the frequent change in composition of the sub-categories used by the DTI: for example, the 1989 PES split the former category of "General Industrial R&D" into "Industrial Innovation" and "Education and Training."[2] Table 2 thus represents the best available information.

4.1 *Industrial Innovation*

Figure 8, which shows the trend in DTI expenditure on "Industrial Innovation", reveals that expenditure increased continually between 1981-82 and 1985-86, but then fell back sharply in 1988-89 before stabilising at approximately £100 million (constant 1988-89 prices).

The "Support for Innovation" (SFI) programme was originally launched in May 1982 to bring together a range of measures available to aid industry. Assistance formerly available through the Research Requirements Boards, the Product and Process Development Scheme and separate schemes like the Microelectronics Application Project was merged into one scheme of support which covered "*any stage of industrial R&D up to and including the launch of new or significantly improved products and processes*".

The overall aims of the SFI programme:

— To stimulate innovation in firms by encouraging R&D.

— To get new products and processes onto the market more quickly.

— To help improve the country's technological base.

These were complemented by special arrangements to promote new technologies and advisory services and other forms of help.

SFI offered support from the early stages of R&D right up to the design, development and launch of new products or processes. All companies and research associations in or closely allied to the manufacturing sector of industry were eligible for support. Assistance was available in three principal forms:

(i) A grant towards eligible costs of the project. On the launch of the SFI programme in May 1982 the grant was raised from 25 per cent to 33.3 per cent (this was returned to its original level in April 1984).

(ii) Exceptionally, shared cost contracts with the Department's contribution of 50 per cent of eligible costs recoverable by a levy on sales.

(iii) Purchase by the Department of pre-production models to be loaned to the potential customers for trials.

From its launch there was a strongly growing demand from individual firms for R&D project support. In 1983-84 there were 2,500 applications, an increase of over 60 per cent on the previous year, and at April 1984 the number was still growing. Despite the restoration of the maximum rate of grant to its previous level of 25 per cent in May 1984, forward commitments had virtually exhausted the 1985-86 allocation by November 1984.

In November 1984 the Government announced a review of industrial innovation support; the review was aimed primarily at addressing the balance between the various aspects of the DTI's work in the R&D field. It began by re-examining the UK's recent technological performance —a combination of different indicators all pointed to the declining impact of the UK's Civil R&D[3]—and went on to address directly the question of Government's role in encouraging industrial innovation. In this respect it was agreed that four types of market failure could, in principle, justify Government involvement:

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[1] The reason for this discrepancy is not clear, but is presumably linked to the incomplete disclosure of all expenditure in the PES.

[2] Prior to this "General Industrial R&D" had comprised "Single Company Projects", "Collaborative Projects", "Education and Training", "Technology Transfer" and "Other Non-Project Support".

[3] In explaining how this pattern emerged the review placed considerable emphasis on weaknesses related to the supply side of the economy and concluded that information and understanding of key technologies was often inadequate and that the training and education system was not meeting the UK's industrial needs to the same extent as was the case overseas.

(i) Where the benefits of a particular project accrue not only to the enterprise bearing the cost, but more widely.

(ii) Where firms and capital markets are unable or unwilling to bear the high risk of R&D investments.

(iii) Where firms cannot readily obtain relevant information.

(iv) Because there is a dynamic two-way interaction between technological momentum and the growth of firms which sometimes demands a longer-term view than that of the market.

At the practical level the Department's experience of past schemes of assistance was assessed. In the area of project support, which had risen to account for 80 per cent of the Department's innovation budget, the evidence showed:

(i) A tendency to support incremental, rather than radical innovation.

(ii) That prospects of commercial exploitation and financial success improved when marketing was tied in to the R&D project work.

(iii) That in many cases financial support for more general measures not specific to particular R&D projects had effectively induced changes in company attitudes to innovation and had accelerated the wider adoption of best management practice.

The review recommended that resources should in future be focussed on those activities which offer greatest leverage from limited funds and which have the most widespread impact across the economy. As a result:

(i) Increased emphasis was placed on various measures of non-project support such as education and training, technology transfer, advisory and consultancy support, and technology awareness programmes.

(ii) The department shifted the balance of its support away from projects in single firms towards collaborative research (Table 3 and Figure 9). Furthermore assistance was made more selective concentrating on projects with a higher innovative content, greater market potential and involving substantial risk in relation to the size of the applicant company (this more stringent approach was relaxed somewhat for small firms).

The review was followed in November 1985 by the establishment of a new Technology Requirements Board and 16 sectoral advisory committees, the main function of which was to advise on the implementation of policy and on the allocation of resources in support of industrial R&D.[1]

In 1987 in their response to the Select Committee's Report on "Civil R&D"[2] the Government announced that the DTI was reviewing its role in encouraging innovation. The main conclusions of this review, as outlined in the White Paper, "DTI—The Department for Enterprise"[3], was that the balance of existing policies should be changed in order to move away from near-market research, and that greater emphasis should be given to:

— Longer term collaborative research between companies.

— Encouraging collaboration between higher educational institutions and industry.

— Encouraging and facilitating the many different aspects of technology transfer.

— Assisting technologically advanced projects in small companies.

These policies thus continued the shift away from support for single company projects started in the 1984 review, Figure 9. As noted above current DTI support for "Industrial Innovation" is focussed on support for longer term collaborative research and technology transfer.

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[1] The new Technology Requirements Board was short lived and was disbanded in 1988.
[2] Cm 175, July 1987.
[3] Cm 278, January 1988.

4.2 *Civil Space Research and Development*

This programme of support is co-ordinated by the British National Space Centre and is aimed at encouraging industry to exploit opportunities in space based on a realistic appraisal of costs and of technological, commercial and other benefits which may be secured.

Expenditure, which totalled £82.4 million in 1988-89, increased steadily at the beginning of the decade but has remained approximately constant in real terms (constant 1988-89 prices) since about 1982-83, Figure 10.

4.3 *Civil Aircraft Research and Demonstration*

This programme aims to help key sectors of the UK aircraft and aero-engine industry to maintain and develop an advanced technological capability and to compete successfully in world markets.

Expenditure increased gradually during the early 1980s, before falling back and stabilizing at around £25 million in 1988-89, Figure 11.

5. International trade (PES Category 4)

The international trade programme covers net expenditure on export promotion, the "Europe Open for Business" campaign, Expo 1992, and subscriptions to GATT and the International Customs Tariff Bureau. Despite a steady decline in expenditure during the mid-1980s, Figure 12, expenditure at £45 million in 1988-89 was approximately the same, in real terms, as in 1981-82.

6. Statutory and regulatory work (PES Category 5)

This programme principally covers expenditure in measurement and technology support for the Department, Warren Spring Laboratory Executive Agency, the Laboratory of the Government Chemist Executive Agency, and other Research Establishment costs. Other expenditure includes Companies House Executive Agency and consumer and investor protection.

The work of the DTI's research establishment is now focussed on research required by government for statutory, regulatory or policy reasons. Furthermore the introduction of new arrangements, based on the development of a true customer-contractor principle, means that customer divisions within the DTI may now place measurement or technology support work with other Government research establishments, or private sector research bodies, depending on who offers the best value for money.

Except for the large increase estimated for 1989-90 expenditure rose steadily in the early 1980s before stabilizing at approximately £55 million, Figure 13.

7. Central and miscellaneous services (PES Category 6)

Expenditure on this programme, which covers all the Department's running costs including capital expenditure, amounted to £212 million in 1988-89. Figure 14 shows that this category of expenditure increased continually, both in cash and real terms, over the period of interest.

TABLE 1.A

DTI—Central Government's own expenditure (as per Table 4.1, Cm 1004, 1990)

£ million (current prices)

Subject Area	1981-82 outturn	1982-83 outturn	1983-84 outturn	1984-85 outturn	1985-86 outturn	1986-87 outturn	1987-88 outturn	1988-89 outturn	1989-90 estimate	1990-91 plans
Voted in Estimates:										
1. Regional and General Industrial Support	791.0	503.0	426.0	475.0	396.0	424.0	283.0	395.0	372.0	334.0
2. Support for Aerospace, Shipbuilding, Steel and Vehicle Manufacture	971.0	645.0	266.0	174.0	223.0	847.0	83.0	668.0	173.0	155.0
3. Support for Industry (including Innovation and Space)	204.0	221.0	310.0	315.0	307.0	308.0	298.0	274.0	297.0	308.0
4. International Trade	31.0	35.0	35.0	29.0	30.0	28.0	30.0	45.0	44.0	46.0
5. Statutory and Regulatory Work[1]	13.0	16.0	19.0	54.0	57.0	53.0	51.0	63.0	217.0	60.0
6. Central and Miscellaneous Services	74.0	80.0	118.0	162.0	156.0	165.0	169.0	212.0	271.0	288.0
Total Voted in Estimates	2,084.0	1,500.0	1,174.0	1,209.0	1,169.0	1,825.0	914.0	1,657.0	1,374.0	1,191.0
Other (non-Voted):										
7. Regional and General Industrial Support	−75.0	−40.0	−27.0	−37.0	−35.0	0.0	0.0	0.0	0.0	0.0
8. Support for Aerospace, Shipbuilding, Steel and Vehicle Manufacture	−76.0	−35.0	−49.0	−26.0	−78.0	0.0	0.0	0.0	0.0	0.0
9. Statutory and Regulatory Work	0.0	0.0	0.0	0.0	0.0	0.0	−1.0	0.0	0.0	0.0
Total Other (non-Voted)	−151.0	−75.0	−76.0	−63.0	−113.0	0.0	−1.0	0.0	0.0	0.0
Total central Government's own expenditure	1,933.0	1,425.0	1,098.0	1,146.0	1,056.0	1,825.0	913.0	1,657.0	1,374.0	1,191.0

[1] From 1979-80 to 1983-84 appears to be included as part of "Support for Industry".

TABLE 1.B

DTI—Central Government's own expenditure (Derived from Table 1.A)

£ million (1988-89 prices)

Subject area	1981-82 outturn	1982-83 outturn	1983-84 outturn	1984-85 outturn	1985-86 outturn	1986-87 outturn	1987-88 outturn	1988-89 outturn	1989-90 estimate	1990-91 plans
Voted in Estimates:										
1. Regional and General Industrial Support	1,107.8	660.3	535.7	570.0	460.0	477.0	303.2	395.0	349.3	294.5
2. Support for Aerospace, Shipbuilding, Steel and Vehicle Manufacture	1,359.9	846.7	334.5	208.8	259.0	952.9	88.9	668.0	162.4	136.7
3. Support for Industry (including Innovation and Space)	285.7	290.1	389.9	378.0	356.6	346.5	319.2	274.0	278.9	271.6
4. International Trade	43.4	45.9	44.0	34.8	34.8	31.5	32.1	45.0	41.3	40.6
5. Statutory and Regulatory Work[1]	18.2	21.0	23.9	64.8	66.2	59.6	54.6	63.0	203.8	52.9
6. Central and Miscellaneous Services	103.6	105.0	148.4	194.4	181.2	185.6	181.0	212.0	254.5	253.9
Total Voted in Estimates	2,918.6	1,969.1	1,476.4	1,450.8	1,357.8	2,053.1	979.1	1,657.0	1,290.1	1,050.1
Other (non-Voted):										
7. Regional and General Industrial Support	−105.0	−52.5	−34.0	−44.4	−40.7	0.0	0.0	0.0	0.0	0.0
8. Support for Aerospace, Shipbuilding, Steel and Vehicle Manufacture	−106.4	−45.9	−61.6	−31.2	−90.6	0.0	0.0	0.0	0.0	0.0
9. Statutory and Regulatory Work	0.0	0.0	0.0	0.0	0.0	0.0	−1.1	0.0	0.0	0.0
Total Other (non-Voted)	−211.5	−98.5	−95.6	−75.6	−131.3	0.0	−1.1	0.0	0.0	0.0
Total central Government's own expenditure	2,707.1	1,870.7	1,380.9	1,375.2	1,226.6	2,053.1	978.0	1,657.0	1,290.1	1,050.1
Correction Factor (1988-89 = 1.0000)	1.4005	1.3128	1.2576	1.2000	1.1615	1.1250	1.0712	1.0000	0.9390	0.8817

[1] From 1979-80 to 1983-84 appears to be included as part of "Support for Industry".

Table 2.A

DTI expenditure on support for industry (derived from paras 35-47, Cm 1004, 1990 and previous PES)

£ million (current prices)

Subject area	1981-82 outturn	1982-83 outturn	1983-84 outturn	1984-85 outturn	1985-86 outturn	1986-87 outturn	1987-88 outturn	1988-89 outturn	1989-90 estimate	1990-91 plans
3.1 Industrial Innovation[1]	102.0	112.0	155.0	236.0	283.0	224.0	239.0	108.5	112.0	121.3
3.2 Education and Training[1]								24.6	26.7	30.3
3.3 Space	44.0	58.0	62.0	60.0	65.0	*73.0*	*71.0*	82.4	80.2	88.8
3.4 Civil Aircraft R&Demonstration	24.0	26.0	29.0	34.0	32.0	*30.0*	*21.0*	25.9	26.8	24.8
Total	170.0	196.0	246.0	330.0	380.0	390.0	410.0	241.4	245.7	265.2

[1] Prior to 1988-89 category of "General Industrial R&D" (which contained bulk of "Support for Innovation") comprised (a) Single Company Projects, (b) Collaborative Projects and (c) Education and Training, Technology Transfer and Other Non-Project Support.

Table 3.A

DTI expenditure on Industrial Innovation (derived from Table 4.12, Cm 1004, 1990 and previous PES)

£ million (current prices)

Subject area	1981-82 outturn	1982-83 outturn	1983-84 outturn	1984-85 outturn	1985-86 outturn	1986-87 outturn	1987-88 outturn	1988-89 outturn	1989-90 estimate	1990-91 plans
3.1.1 Collaborative R&D	#	#	#	#	40.0	62.0	74.0	67.7	77.8	94.2
3.1.2 Single Company Projects[1]	#	#	#	#	99.0	75.0	69.0	28.1	20.5	12.8
3.1.3 Technology Transfer	#	#	#	#	#	#	#	12.7	13.7	14.3
3.1.4 Non-Project Support[2]	#	#	#	#	81.0	86.0	*96.0*	*106.0*	*106.0*	#
Total	102.0	112.0	155.0	236.0	220.0	223.0	239.0	214.5	218.0	121.3

[1] Including SMART.

[2] Includes education and training, technology transfer and other non-project support.

Table 4.A

DTI expenditure on CAA Launch Aid (Source: DTI)

£ million (current prices)

Subject area	1981-82 outturn	1982-83 outturn	1983-84 outturn	1984-85 outturn	1985-86 outturn	1986-87 outturn	1987-88 outturn	1988-89 estimate	1989-90 plans	1990-91 plans
5.1 Launch Aid Payments	150.4	90.8	83.5	83.3	105.8	119.0	52.6	98.4	133.6	#
Launch Aid Levy Receipts	-26.3	-26.6	-24.6	-12.8	-15.2	-19.2	-25.9	-22.4	-42.6	#
Net Launch Aid	124.1	64.2	58.9	70.5	90.6	99.8	26.7	76.0	91.0	#

Table 2.B

DTI expenditure on support for industry (derived from Table 2.A)

£ million (1988-89 prices)

Subject area	1981-82 outturn	1982-83 outturn	1983-84 outturn	1984-85 outturn	1985-86 outturn	1986-87 outturn	1987-88 outturn	1988-89 outturn	1989-90 estimate	1990-91 plans
3.1 Industrial Innovation[1]	142.8	147.0	194.9	283.2	328.7	252.0	256.0	108.5	105.2	106.9
3.2 Education and Training[1]								24.6	25.1	26.7
3.3 Space	61.6	76.1	78.0	72.0	75.5	82.1	76.1	82.4	75.3	78.3
3.4 Civil Aircraft R&Demonstration	33.6	34.1	36.5	40.8	37.2	33.8	22.5	25.9	25.2	21.9
Constant prices	238.1	257.3	309.4	396.0	441.4	390.0	410.0	241.4	230.7	233.8

[1] Prior to 1988-89 category of "General Industrial R&D" (which contained bulk of "Support for Innovation") comprised (a) Single Company Projects, (b) Collaborative Projects and (c) Education and Training, Technology Transfer and Other Non-Project Support.

# Data not available. Values in italics are estimates.

TABLE 3.B

DTI expenditure on Industrial Innovation (derived from Table 3.A)

£ million (1988-89 prices)

Subject area	1981-82 outturn	1982-83 outturn	1983-84 outturn	1984-85 outturn	1985-86 outturn	1986-87 outturn	1987-88 outturn	1988-89 outturn	1989-90 estimate	1990-91 plans
3.1.1 Collaborative R&D	#	#	#	#	46.5	69.8	79.3	67.7	73.1	83.1
3.1.2 Single Company Projects[1]	#	#	#	#	115.0	84.4	73.9	28.1	19.2	11.3
3.1.3 Technology Transfer	#	#	#	#	#	#	#	12.7	12.9	12.6
3.1.4 Non-Project Support[2]	#	#	#	#	94.1	96.8	102.8	106.0	99.5	#
Total	128.3	134.4	180.0	265.5	235.7	250.9	256.0	214.5	204.7	106.9

[1] Including SMART.

[2] Includes education and training, technology transfer and other non-project support.

TABLE 4.B

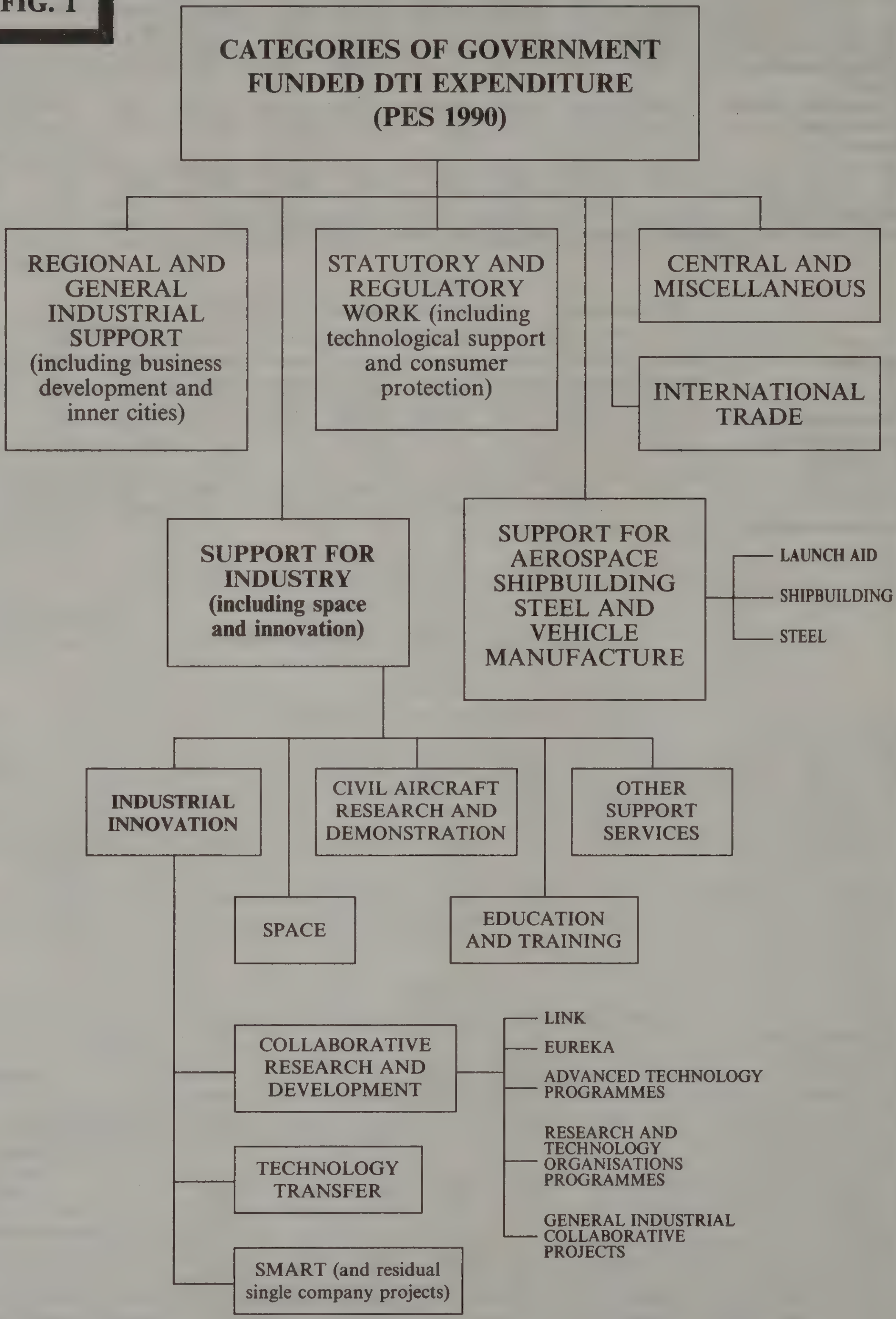
DTI expenditure on CAA Launch Aid (derived from Table 4.A)

£ million (1988-89 prices)

Subject area	1981-82 outturn	1982-83 outturn	1983-84 outturn	1984-85 outturn	1985-86 outturn	1986-87 outturn	1987-88 outturn	1988-89 estimate	1989-90 plans	1990-91 plans
5.1 Launch Aid Payments	210.6	119.2	105.0	100.0	122.9	133.9	56.3	98.4	125.4	#
Launch Aid Levy Receipts	-36.8	-34.9	-30.9	-15.4	-17.7	-21.6	-27.7	-22.4	-40.0	#
Net Launch Aid	173.8	84.3	74.1	84.6	105.2	112.3	28.6	76.0	85.4	#

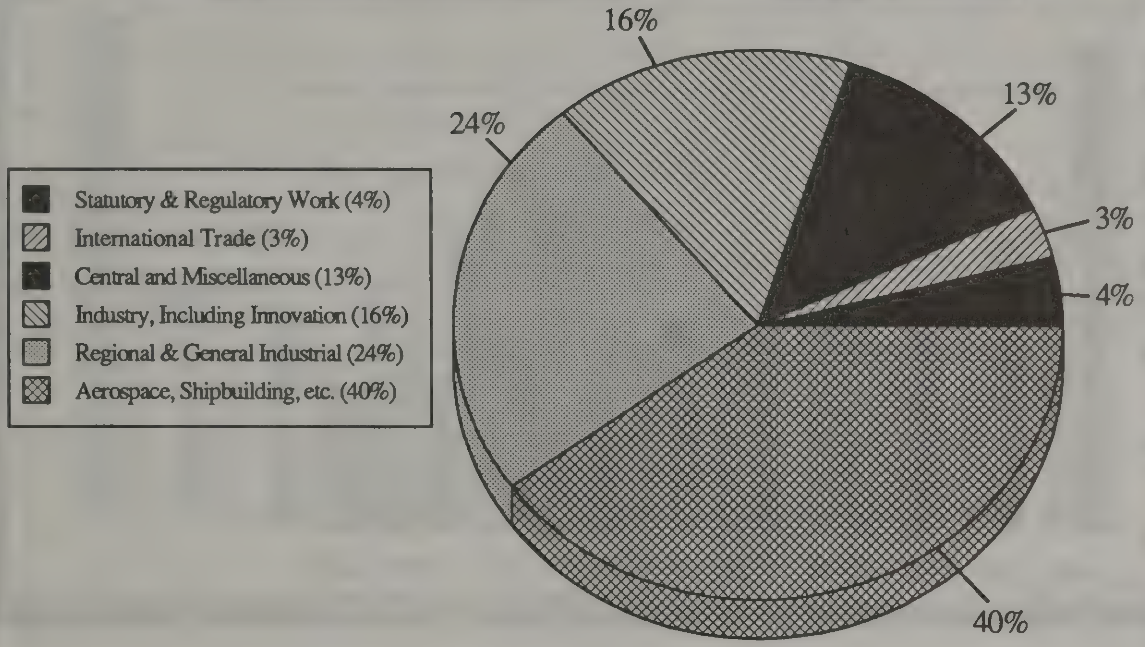
# Data not available.

FIG. 1


CATEGORIES OF GOVERNMENT FUNDED DTI EXPENDITURE (PES 1990)
REGIONAL AND GENERAL INDUSTRIAL SUPPORT (including business development and inner cities)
STATUTORY AND REGULATORY WORK (including technological support and consumer protection)
CENTRAL AND MISCELLANEOUS
INTERNATIONAL TRADE
SUPPORT FOR INDUSTRY (including space and innovation)
SUPPORT FOR AEROSPACE SHIPBUILDING STEEL AND VEHICLE MANUFACTURE
LAUNCH AID
SHIPBUILDING
STEEL
INDUSTRIAL INNOVATION
CIVIL AIRCRAFT RESEARCH AND DEMONSTRATION
OTHER SUPPORT SERVICES
SPACE
EDUCATION AND TRAINING
COLLABORATIVE RESEARCH AND DEVELOPMENT
LINK
EUREKA
ADVANCED TECHNOLOGY PROGRAMMES
RESEARCH AND TECHNOLOGY ORGANISATIONS PROGRAMMES
GENERAL INDUSTRIAL COLLABORATIVE PROJECTS
TECHNOLOGY TRANSFER
SMART (and residual single company projects)

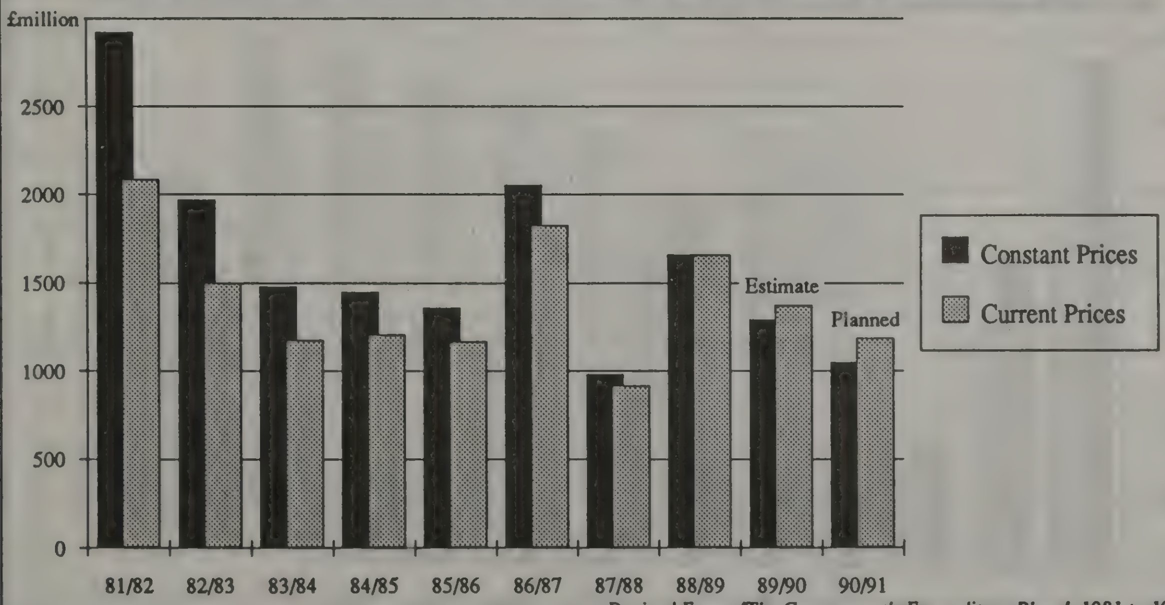
Derived From: The Government's Expenditure Plans' 1990

Fig. 2: BREAKDOWN OF DTI EXPENDITURE (1988/89)



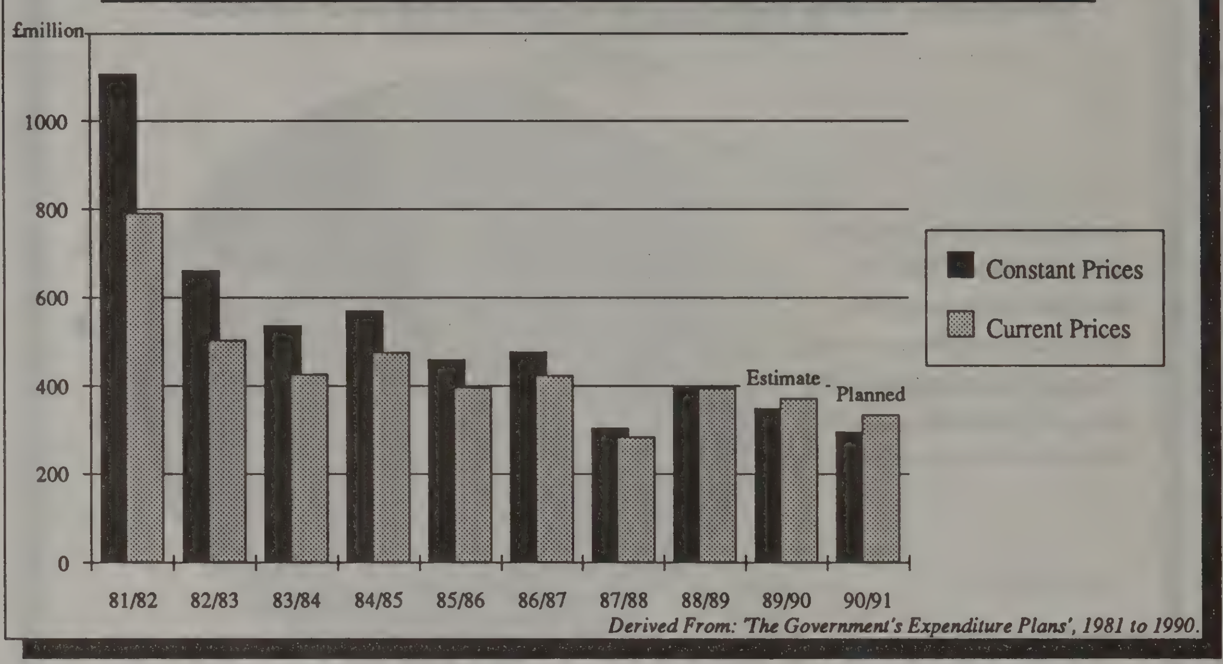
Derived From: 'The Government's Expenditure Plans, 1990'.

FIG. 3: DTI EXPENDITURE OVER THE PERIOD 81/82 TO 90/91



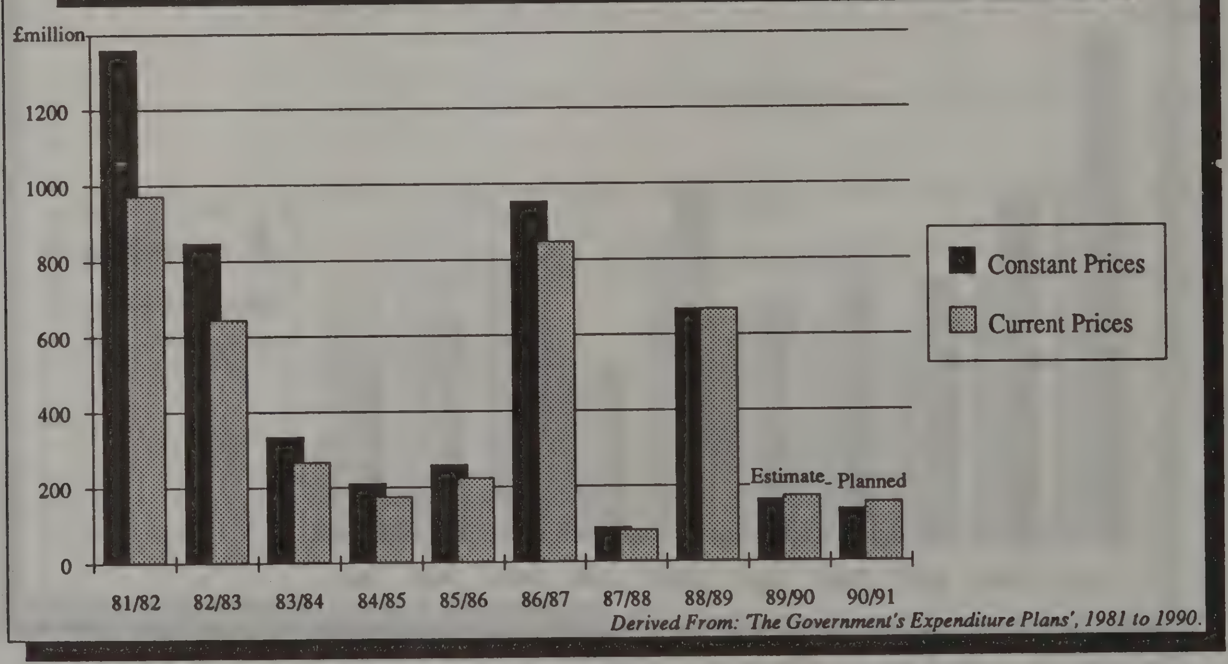
Derived From: 'The Government's Expenditure Plans', 1981 to 1990

FIG. 4: DTI 'REGIONAL AND GENERAL INDUSTRIAL SUPPORT'



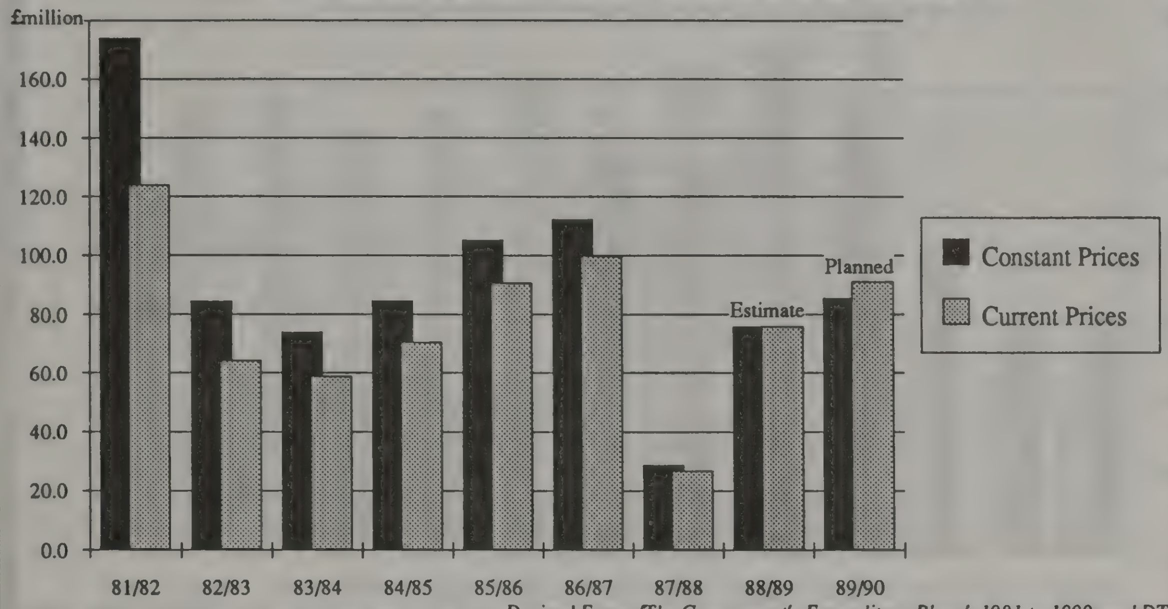
Derived From: 'The Government's Expenditure Plans', 1981 to 1990.

FIG. 5: DTI 'SUPPORT FOR AEROSPACE, SHIPBUILDING AND STEEL'



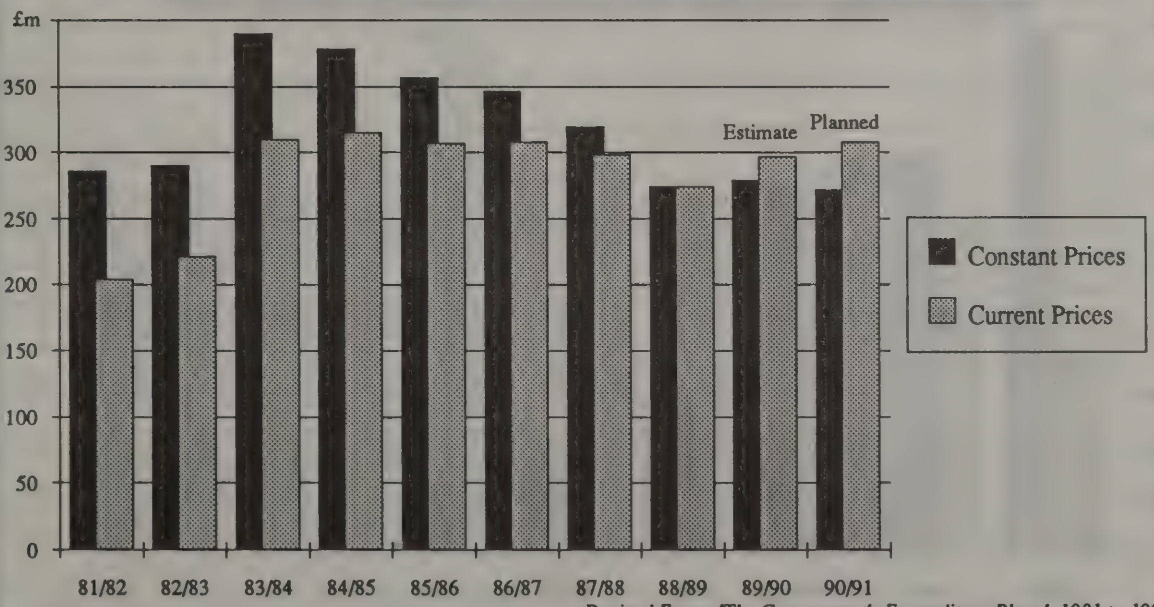
Derived From: 'The Government's Expenditure Plans', 1981 to 1990.

FIG. 6: DTI NET LAUNCH AID EXPENDITURE



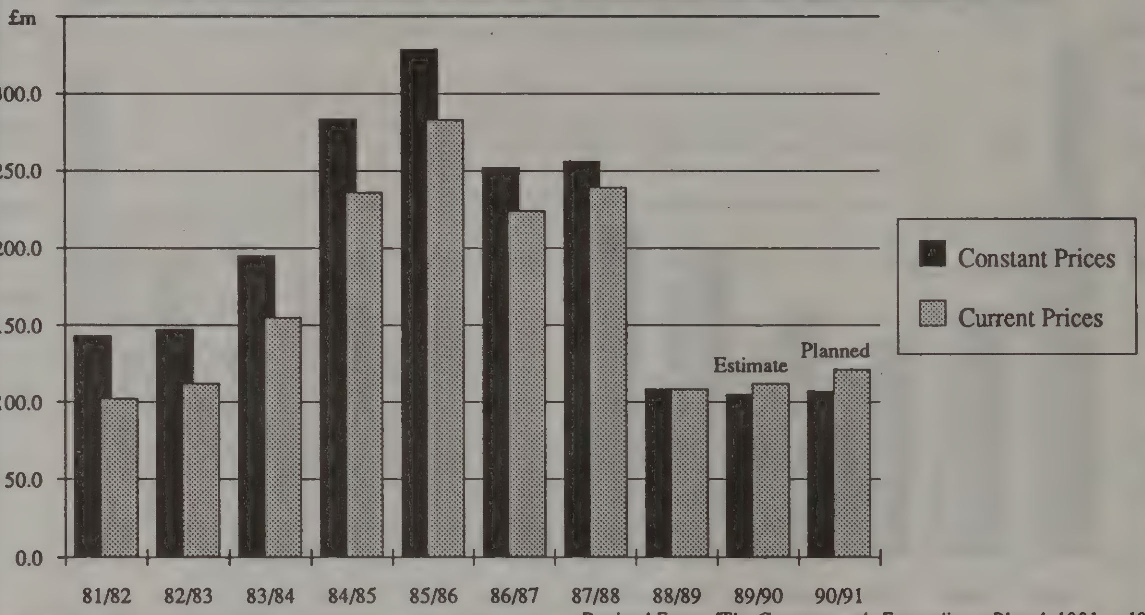
Derived From: 'The Government's Expenditure Plans', 1981 to 1990, and DTI.

FIG. 7: DTI SUPPORT FOR INDUSTRY (Including Innovation)



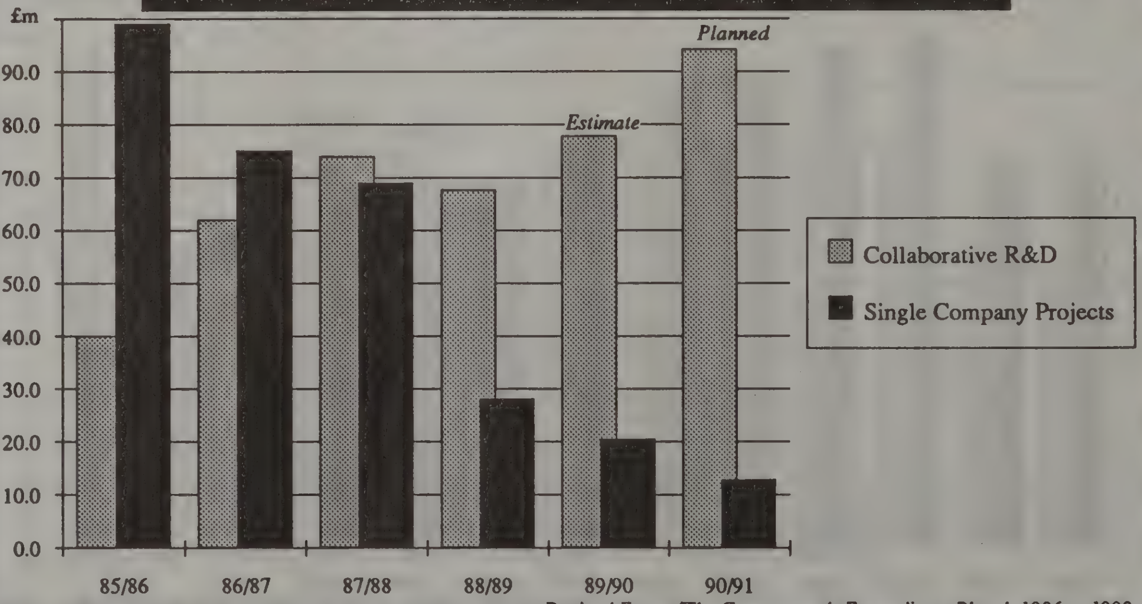
Derived From: 'The Government's Expenditure Plans', 1981 to 1990.

Fig.8 : TREND IN DTI 'SUPPORT FOR INNOVATION'



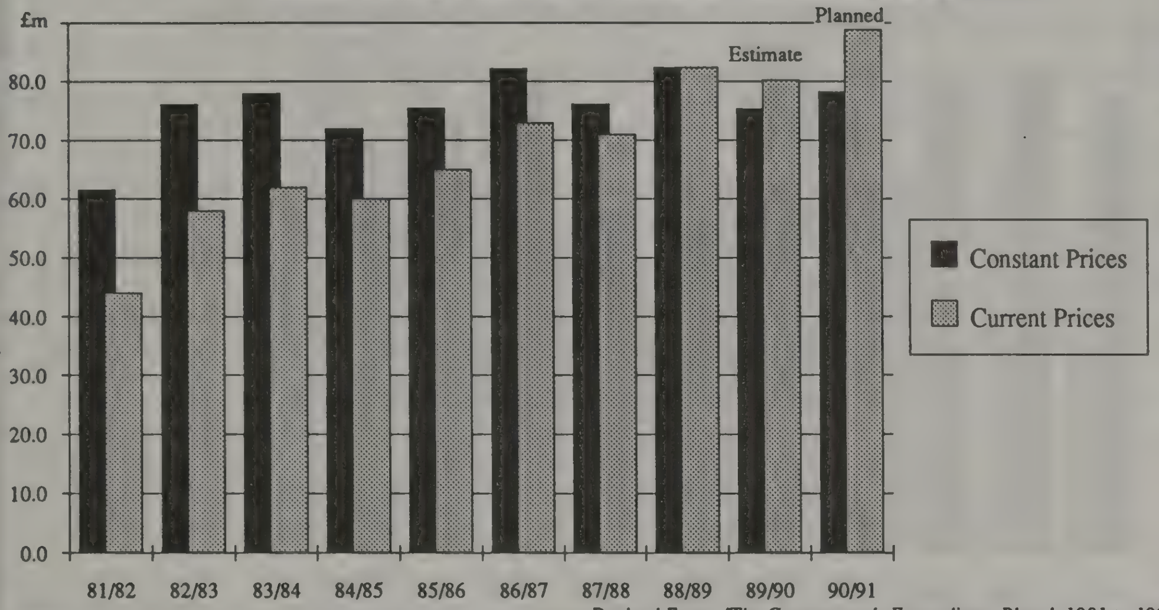
Derived From: 'The Government's Expenditure Plans', 1981 to 1990.

FIG. 9: TREND IN DTI SUPPORT FOR COLLABORATIVE AND SINGLE COMPANY PROJECTS (Current Prices)



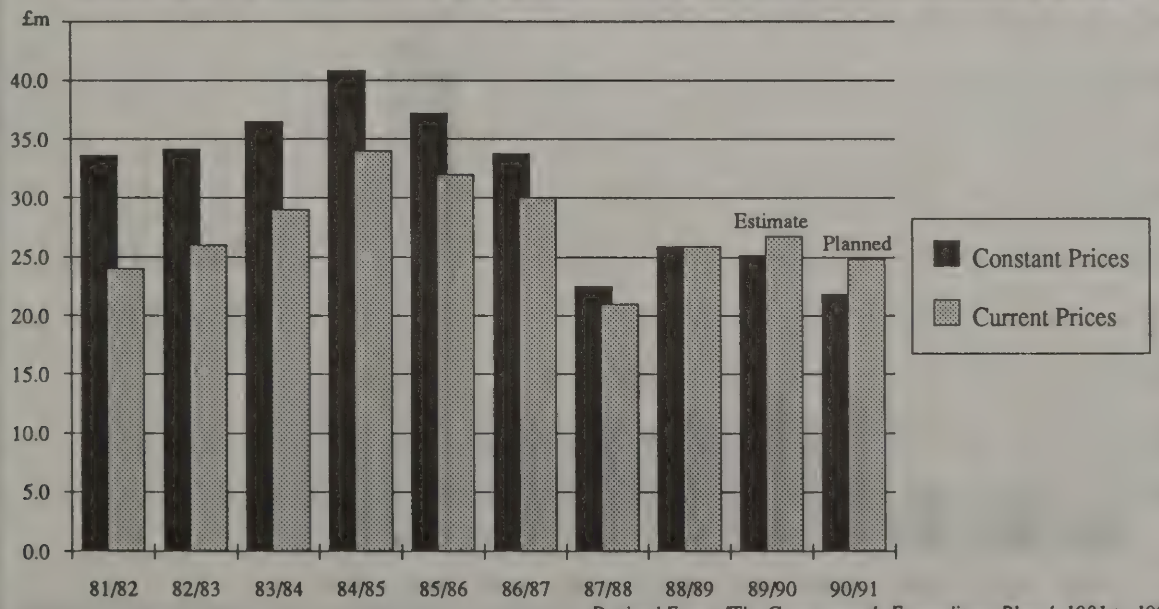
Derived From: 'The Government's Expenditure Plans', 1986 to 1990.

FIG. 10: DTI SUPPORT FOR CIVIL SPACE R&D



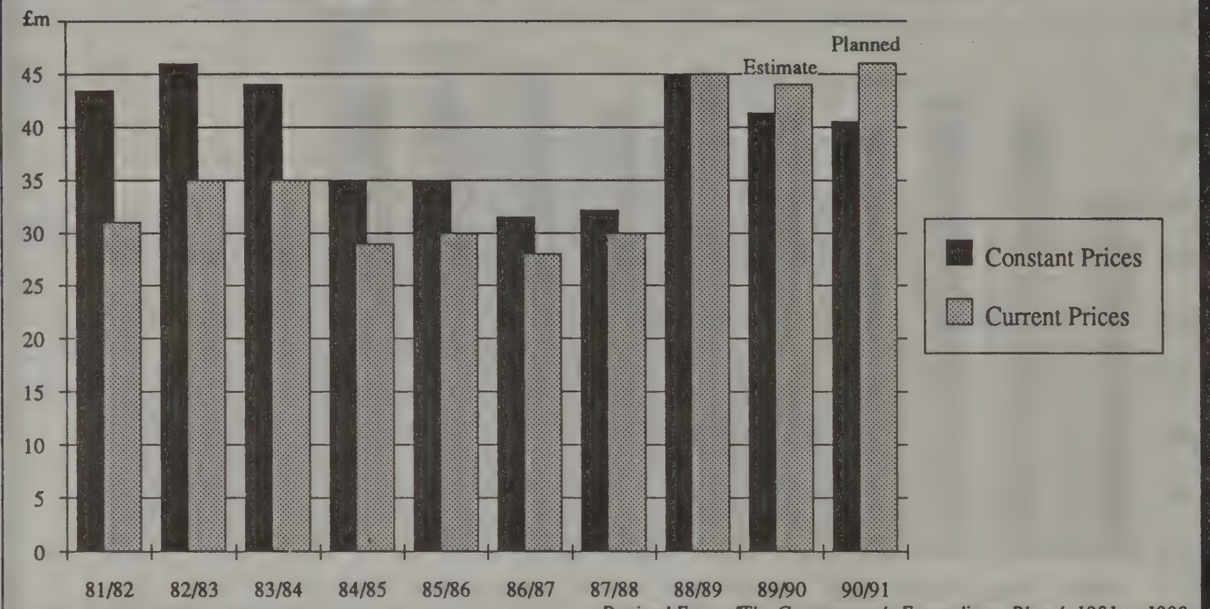
Derived From: 'The Government's Expenditure Plans', 1981 to 1990.

FIG. 11: DTI SUPPORT FOR CIVIL AIRCRAFT R&DEMONSTRATION



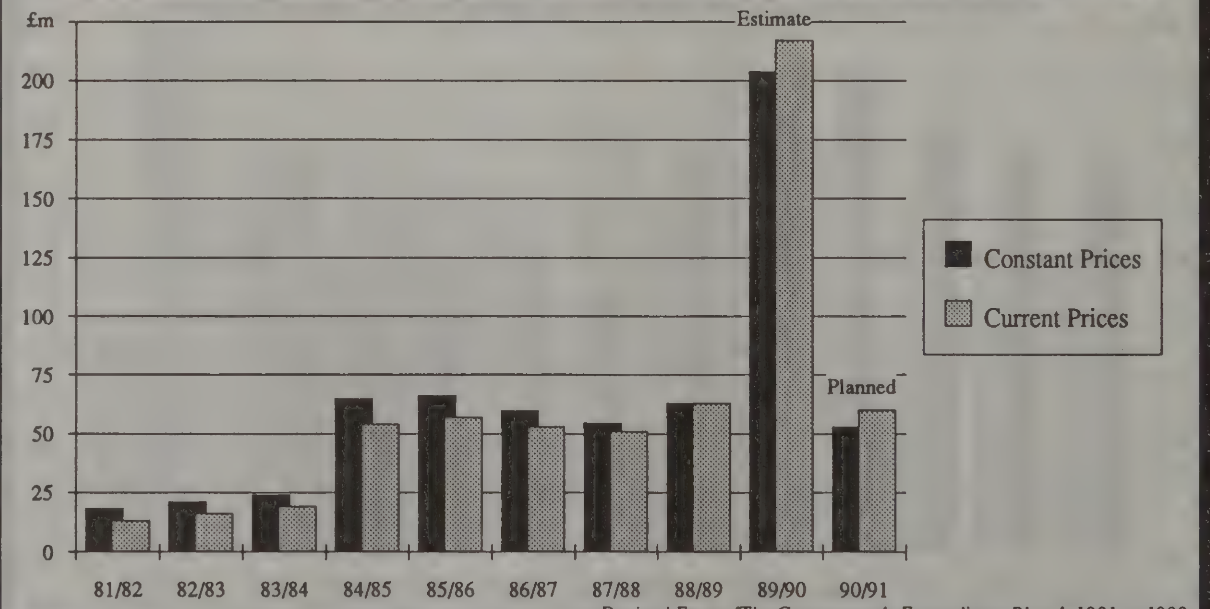
Derived From: 'The Government's Expenditure Plans', 1981 to 1990.

FIG. 12: DTI 'SUPPORT FOR INTERNATIONAL TRADE'



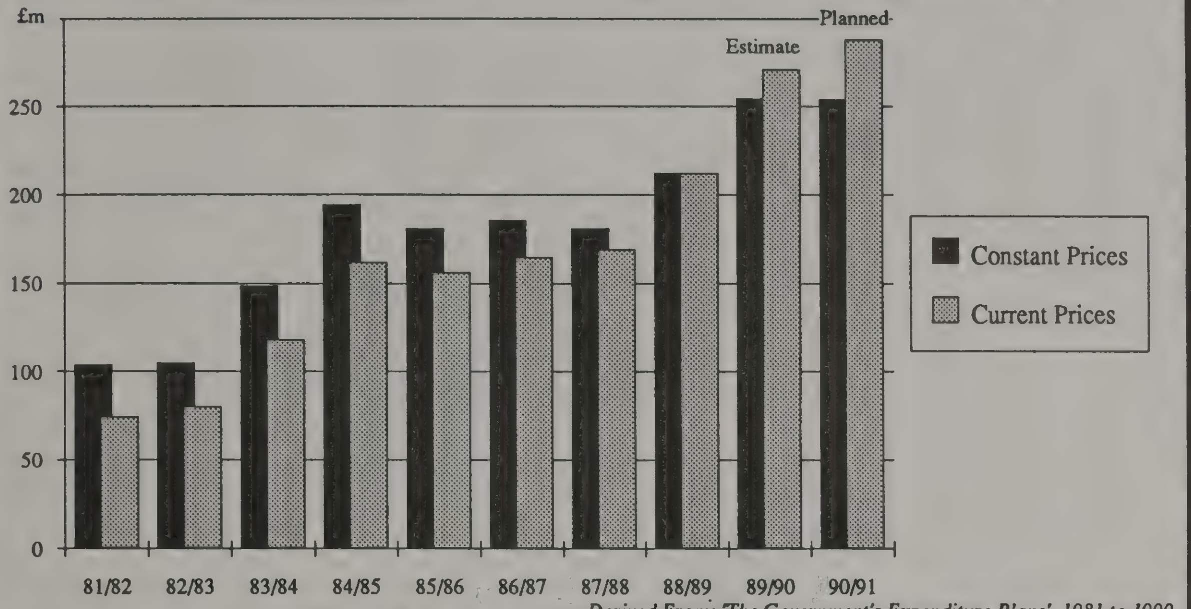
Derived From: 'The Government's Expenditure Plans', 1981 to 1990.

FIG. 13: DTI 'SUPPORT FOR STATUTORY AND REGULATORY WORK'



Derived From: 'The Government's Expenditure Plans', 1981 to 1990.

FIG. 14: DTI 'CENTRAL AND MISCELLANEOUS SUPPORT'



Derived From: 'The Government's Expenditure Plans', 1981 to 1990.

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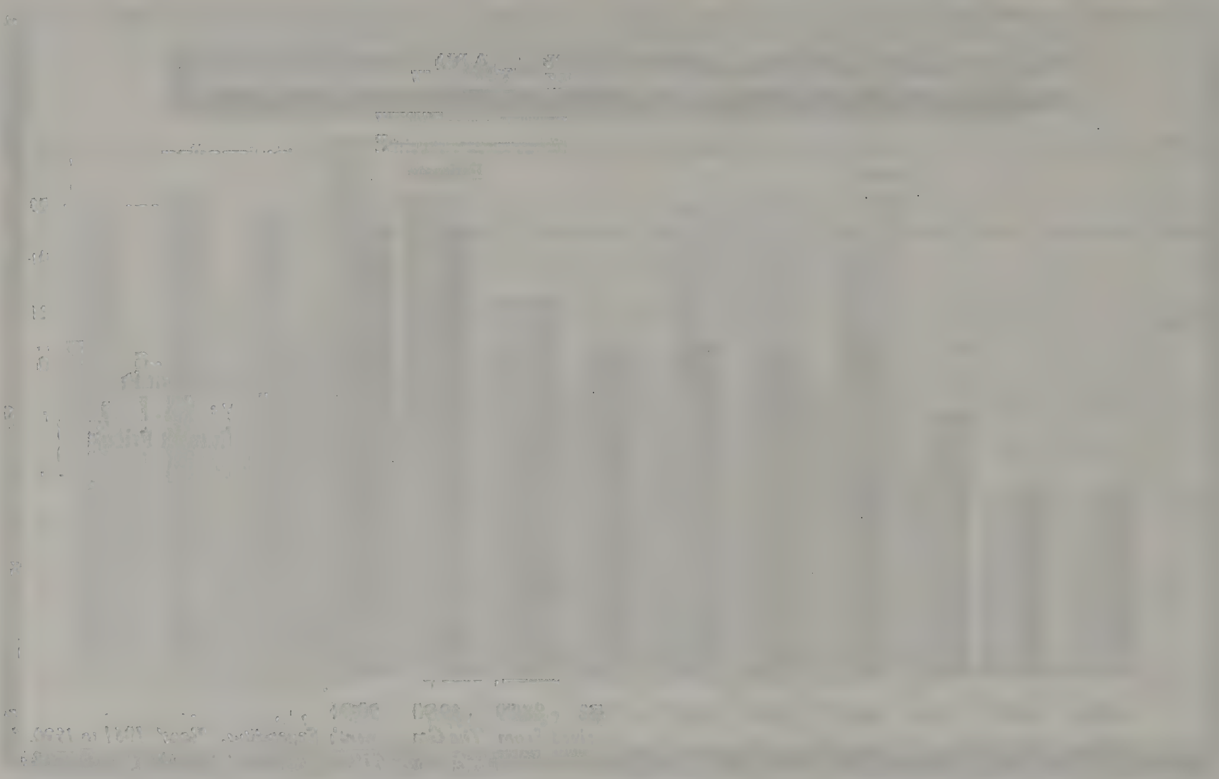
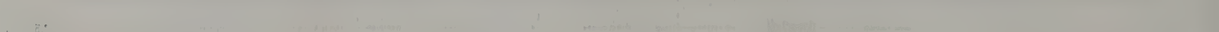


STATUTORY AND REGULATORY WORK



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